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(54) Method and system for transmission and reception of punctured convolutionally encoded data

Verfahren und Einrichtung zum Senden und Empfangen von punktierten, faltungskodierten Daten

Procédé et dispositif de transmission et de réception de données poinçonnées et codées convolutionnellement

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Description

[0001] The present invention relates to a digital wireless transmission and reception system, a transmission and reception device, and a method of transmission and reception, in which quality of communication is improved.

[0002] There are a number of methods for improving quality of communication in the digital wireless transmission such as an error-correction coding, a diversity transmission and reception, and a combination of them. A well-known method of error-correction coding among the above is a convolution coding having a superior performance in the error correction. One example is a newly devised method which combines interleaving and puncturing with the convolution coding, as disclosed in Japanese Patent Laid-Open Publication No. H08-298466. The paper "Complementary Punctured Convolutional (CPC) codes and Their Applications" (IEEE Transactions on Communications, June 1995) by Samir Kallel discloses an hybrid ARQ scheme in which different versions of a packet can be created using complementary perforation matrixes. This can also be applied in systems implementing transmission diversity. A method of the prior art for improving quality of communication using a combination of the convolution coding, the puncturing and the time-diversity will be briefly described by referring to Figs. 8A and 8B.

[0003] In a transmission device 800 of Fig. 8A, a series of information data 851 to be transmitted is punctured (thinning-out process) in a unit of a fixed amount of data block by a puncturing unit 802 in order to reduce an amount of communication traffic in a transmission pathway, after it is convolution-coded by a convolutional coding unit 801. A puncturing (thinning-out) location within the data block is stored as a puncturing pattern in a puncturing pattern generator 803, from where it is supplied to the puncturing unit 802.

[0004] An example shown in Fig. 8B will be described now in detail. A series of input information data $\{a_0, b_0, c_0, d_0, ...\}$ is converted into a series of convolution-coded data $\{a_1, a_2, b1, b_2, c_1, c_2, d_1, d_2, ...\}$ by the convolutional coding unit 801 having a constraint length of 3 and a coding rate of 1/2. The puncturing unit 802 removes b_2, d_1, etc., and outputs a series of punctured data $\{a_1, a_2, b_1, c_1, c_2, d_2, ...\}$, when a puncturing pattern 803b is supplied from the puncturing pattern generator 803. This series ofpunctured data is a combination of a series of data $\{a_1, b_1, c_1, e_1, ...\}$, which is obtained by deleting data corresponding to a_0 position in an upper row of the puncturing pattern 803b from a series of data $\{a_1, b_1, c_1, d_1, e_1, ...\}$ corresponding to the upper row of the puncturing pattern 803b out of the foregoing series of convolution-coded data, and another series of data $\{a_2, c_2, d_2, e_2, ...\}$, which is obtained by deleting data corresponding to a_0 position in a lower row of the puncturing pattern 803b from a series of data $\{a_2, b_2, c_2, d_2, e_2, ...\}$ corresponding to the lower row of the puncturing pattern 803b out of the series of convolution-coded data.

[0005] A time-diversity modulator / transmitter 804 repeats modulation and transmission of the series of punctured data for a predetermined number of times in response to a diversity transmission timing control signal supplied by a diversity transmission timing controller 805 at intervals of a predetermined time.

[0006] In a receiving device 810, the predetermined time for the transmission device 800 to repeat the time-diversity transmission is set in advance with a diversity reception timing controller 811, so that the diversity reception timing controller 811 outputs a timing control signal for starting a time-diversity reception according to the set time. A time-diversity receiver / demodulator 812 receives and demodulates a signal transmitted repeatedly in response to the control signal of a time-diversity reception timing, and outputs a series of demodulated data of every diversity branch (every repeat time). In this example, description is being made on an assumption that a result of demodulation for each symbol in the series of demodulated data is a quantized data in a resolution of four bits, and a mark and a space have their respective values equivalent to -7 and +7 under the condition of no influence of noises.

[0007] A puncturing pattern generator 813 stores a puncturing pattern, which is identical to the puncturing pattern 803b used in the puncturing unit 802 of the transmission device. A depuncturing unit 814 uses this puncturing pattern to depuncture the series of demodulated data of every diversity branch, and outputs a series of depunctured data of every diversity branch. The depuncturing is a process in which the punctured position is filled with a dummy data such as a value of 0 corresponding to a middle value between the soft decision value of -7 corresponding to a mark and the soft decision value of +7 corresponding to a space, for example. In the case of the foregoing series of punctured data $\{a_1, a_2, b_1, c_1, c_2, d_2, ...\}$, the depuncturing unit 814 outputs a series of depunctured data $\{a_1, a_2, b_1, 0, c_1, c_2, 0, d_2, ...\}$.

[0008] The series of depunctured data of every diversity branch obtained here is combined symbol by symbol in a unit of block by a combining unit 815, and they are convolution-decoded with a method such as the Viterbi soft quantization by a convolutional decoding unit 816, which in turn outputs a series of decoded information data. There may be a case where the depuncturing and the combining are reversed in their order of transaction. The devices can thus achieve an improvement in quality of communication for both of the error-correction coding and diversity with the structure as described above, by performing punctured-convolution-coding and time-diversity transmission on the information data to be transmitted, and also combining and depunctured-convolution-decoding after time-diversity reception of the data at the receiving side.

[0009] However, the structure of Figs. 8A and 8B

punctures certain identical locations in the series of convolution-coded data (error-correction code word) in each of the repeated transmissions by way of the time-diversity transmission. Therefore, these certain punctured locations and vicinity of them become susceptible to noises, as they become low in likelihood when convolution-decoding them, since they are treated as values having a large length between codes from both of the mark and the space at the receiving side.

[0010] The present invention is intended to solve the above problems and it aims at preventing a likelihood of certain information data from declining by adopting a different puncturing pattern for each of diversity branches when transmitting and receiving mainly information data by a combination of the punctured convolution-coding and the diversity, thereby improving quality of communication. These objects are solved by the subject matters of the independent claims. Further embodiments are defined by their dependent claims.

The transmission and reception system, the transmission and/or reception device, and the method of transmission and/or reception executes the diversity transmission and reception of a plurality of different series of error-correction code word, as individual diversity branch data, by obtaining them through puncturing and convolution-coding the identical series of information data with different forms of puncturing patterns. Accordingly, the present invention is able to prevent a likelihood of certain information data from declining, and to further improve a quality of communication.

Figs. 1A and 1B are drawings depicting block diagrams of a time-diversity transmission and reception system of a first exemplary embodiment of the present invention;

Figs. 2A, and 2B are drawings depicting a block diagram of a multiple puncturing pattern generator of a second exemplary embodiment of the present invention, and an example of generated puncturing patterns;

Fig. 3 is a drawing depicting a block diagram of a receiving device of a time-diversity transmission and reception system of a third exemplary embodiment of the present invention;

Fig. 4 is a drawing depicting a block diagram of a transmission and reception system of a fourth exemplary embodiment of the present invention;

Fig. 5 is a drawing depicting a block diagram of a transmission and reception system of a fifth exemplary embodiment of the present invention;

Fig. 6 is a drawing depicting a block diagram of a transmission and reception system of a sixth exemplary embodiment of the present invention;

Fig. 7 is a drawing depicting a block diagram of a satellite-path diversity transmission and reception system of a seventh exemplary embodiment of the present invention; and

Figs. 8A and 8B are drawings depicting block diagrams of an example of a time-diversity transmission and reception system of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] The present invention relates to a transmission and reception system, a transmission and reception device and a method of transmission and reception, which realize an improvement in quality of communication by taking steps of:

(a) convolution-coding a data to be transmitted;

(b) producing a plurality of different series of punctured data by puncturing it in a unit of a predetermined block with a plural form of puncturing patterns; and

(c) transmitting each of the series of punctured data through a plurality of paths (diversity branches), and at a receiving side, by taking steps of:

> (a) receiving and demodulating the signals through the plurality of paths (diversity branches);
>
> (b) depuncturing the signals with puncturing patterns corresponding to them;
>
> (c) combining them from symbol to symbol in a unit of block; and
>
> (d) reconstituting the original data by convolution-decoding them.

[0012] Exemplary embodiments of the present invention will be described hereinafter by referring to Fig. 1A through Fig. 7.

First Exemplary Embodiment

[0013] A first exemplary embodiment of the present invention relates to a time-diversity transmission and reception system for transmitting and receiving the above-cited plurality of different series of punctured data via a plurality of paths with carrier waves of the same frequency (same assigned range of frequency) but different in time (allotted time for transmission).

[0014] Fig. 1A depicts a structure of a time-diversity transmission and reception system of the first exemplary embodiment, and Fig. 1B is a drawing for use in describing an essential part of the same. A primary difference of the present structure from that shown in Figs. 8A and 8B as described in the prior art system is that the puncturing pattern generator provided in each of the transmission device and the receiving device for generating a single form of the puncturing pattern is replaced by a multiple puncturing pattern generator for generating a plurality of puncturing patterns in various forms. Although the present embodiment is an example in which transmission and reception are made via two paths in order to simplify the description, a number of

paths can be expanded easily without impairing the universality.

[0015] First, a convolutional coding unit 101 convolution-codes a series of input information data 121, and outputs it as a series of convolution-coded data 125. The convolutional coding unit 101 in Fig. 1B is an example of circuit structure for convolution coding in a constraint length of 3 and a coding rate of 1/2.

[0016] On the other hand, a multiple puncturing pattern generator 102 generates two forms of puncturing patterns having an identical puncturing rate, but different in block pattern of puncturing with each other. For instance, it generates two different puncturing patterns, a pattern A, 102a, and a pattern B, 102b, both having a same puncturing rate of 17/22 (a number of bits after puncturing / a number of bits before the puncturing), as shown in Fig. 1B. In the figure, a numeral "0" indicates a location where the puncturing (thinning-out) is made within the puncturing patterns, and the puncturing locations are set in a manner that they do not overlap with each other between the patterns A and B.

[0017] A puncturing unit 103 punctures the series of convolution-coded data 125 by using the two puncturing patterns, the pattern A, 102a, and the pattern B, 102b, and outputs respective series of punctured data 126a and 126b.

[0018] Although the foregoing structure comprises the multiple puncturing pattern generator 102 and the puncturing unit 103 as being two separate blocks, the two functions can be combined into one block. In other words, the puncturing unit may have the function of generating plural forms of puncturing patterns as well as the function of puncturing.

[0019] A diversity transmission timing controller 104 outputs two series of diversity transmission timing control signal 123 for the transmission device 100 to make time-diversity transmission at intervals of a predetermined time.

[0020] A time-diversity modulator / transmitter 105 carries out the time-diversity transmission twice in response to each of the two orders of diversity transmission timing control signal 123 delivered by the diversity transmission timing controller 104 by using the series of punctured data 126a for a first data of the time-diversity modulation and transmission and the series of punctured data 126b for a second data of the time-diversity modulation and transmission.

[0021] On the other hand, the predetermined time for the transmission device 100 to carry out the time-diversity transmission is set in advance with a diversity reception timing controller 111 of a receiving device 110, so that the controller 111 outputs a diversity reception timing control signal 124 twice on time for a start of time-diversity reception.

[0022] A time-diversity receiver / demodulator 112 receives and demodulates the time-diversity transmitted signal in response to the diversity reception timing control signal 124, and outputs two series of demodulated data 127a and 127b of every diversity branch.

[0023] A multiple puncturing pattern generator 113 generates two forms of puncturing patterns that are identical to those produced by the multiple puncturing pattern generator 102 of the transmission device 100.

[0024] A depuncturing unit 114 depunctures the series of demodulated data 127a and 127b by using the puncturing patterns 102a and 102b supplied by the multiple puncturing pattern generator 113, one after another, and outputs series of depunctured data 128a and 128b. In this depuncturing process, digital values in the series of demodulated data are output with their original values for unpunctured locations in the puncturing patterns, and a middle value between values of a mark and a space is inserted in each of the punctured locations. For instance, if individual symbols in the series of demodulated data are output in quantized soft decision values in a resolution of four bits, the mark and the space have values of -7 and +7 respectively, and a middle value between them corresponds to "0".

[0025] In the foregoing structure, although the multiple puncturing pattern generator 113 and the depuncturing unit 114 have been described as separate blocks, both of the functions can be combined into one block. For example, the depuncturing unit may have the function of generating two forms of puncturing patterns that are identical to those generated by the multiple puncturing pattern generator 102 of the transmission device 100, as well as the function of depuncturing.

[0026] A combining unit 115 compounds the series of depunctured data 128a and 128b of every diversity branch, symbol by symbol in a unit of block. In the case of foregoing example, two 4 bits of digital data are added together. In the present exemplary embodiment, the addition of digital values in locations of the specific symbols does not leave the value "0" intact, since the locations where the value "0" is inserted in the depuncturing process differ between the two series of depunctured data 128a and 128b, as a matter of course. In the prior art techniques, on the other hand, a result of addition of digital values in certain symbols has left the value "0" unchanged after depuncturing, thereby causing the likelihood extremely low, since puncturing locations in blocks during the puncturing process have not varied, but remained same throughout time-diversity.

[0027] A convolutional decoding unit 116 decodes the series of combined results output by the combining unit 115 with a method such as the Viterbi soft quantization and the like means, and outputs a decoded series of information data 122.

[0028] As has been described, the present exemplary embodiment of this invention obtains two different series of punctured data by puncturing identical series of information data with two different forms of puncturing patterns, and executes time-diversity transmission of the obtained series of data as transmission data of individual diversity branches. A receiver compounds the transmitted data after depuncturing them by using two differ-

ent forms of puncturing patterns, which are identical to those of the transmission side, and carries out convolution-decoding. In this way, the invention prevents a reduction of likelihood from concentrating on certain information data, since the punctured locations differ between individual diversity branches, so as to improve quality of the communication.

[0029] Although the described embodiment is an example that uses two forms of puncturing patterns, this is not restrictive. A concept of the present exemplary embodiment is adaptable even to a structure, in which a number of puncturing patterns generated by the multiple puncturing pattern generator of the transmission device and the receiving device is increased to three forms or more, and a number of branches for the time-diversity transmission and reception is increased to three or more, so long as these branches include different puncturing patterns.

[0030] Also, while the present exemplary embodiment as described above includes Fig. 1B showing an example of circuit structure for the convolution coding in a constraint length of 3 and a coding rate of 1/2, and describes the puncturing as being made in a puncturing rate of 17/22, they are not restrictive as it is needless to mention.

[0031] Further, although the puncturing locations are said to be not overlapping among the plurality of puncturing patterns in the described embodiment, this is not restrictive, as some of the puncturing locations may overlap.

[0032] Moreover, it goes without mentioning that the system can be constructed in a manner that the convolutional coding unit is supplied with a series of data processed by other error-correction coding or error-detection coding as the series of information data. Or, the system may comprise a processing unit for interleaving and/or another unit for composing a burst, inserted between the puncturing unit and the modulator / transmitter.

Second Exemplary Embodiment

[0033] A second exemplary embodiment relates to an improvement of the multiple puncturing pattern generator in the time-diversity transmission and reception system of the first exemplary embodiment. The present system produces a reference matrix for generating a puncturing pattern at first, and generates plural forms of puncturing patterns by converting the reference matrix.

[0034] Fig. 2A shows an internal structure of a multiple puncturing pattern generator (corresponding to the generators 102 and 113 in Figs. 1A and 1B) of the second exemplary embodiment. In Fig. 2A, a reference matrix generator 201 is for generating a matrix for use as a reference when generating a plurality of puncturing patterns, and a matrix 201 a is an example of the reference matrix generated by it.

[0035] A matrix converter 202 outputs a plurality of puncturing patterns by converting a row, a column or matrix elements of the reference matrix 201 a according to a predetermined process. In the example of Fig. 2A, the matrix converter 202 outputs two forms of puncturing patterns 202a and 202b by exchanging rows in the reference matrix 201 a. That is, the multiple puncturing pattern generator 102 first generates a matrix data from the reference matrix 201a without exchanging any of the rows, and outputs it as the puncturing pattern 202a. It then exchanges between a first row and a second row of the reference matrix 201 a, and outputs it as the puncturing pattern 202b. The structure and function of the time-diversity transmission and reception system of the second exemplary embodiment, other than the foregoing, remain the same as those of Figs. 1A and 1B.

[0036] With the present exemplary embodiment as described above, the system is able to save a memory capacity as compared to the system of the first exemplary embodiment, since it stores only one matrix as a reference for the multiple puncturing pattern generator to generate a plurality of puncturing patterns.

[0037] Although in the foregoing description of Fig. 2A in the present exemplary embodiment, the matrix converter adopts a method for exchanging matrix elements in rows of the reference matrix, this is not restrictive, and it may use a method of generating a plurality of puncturing patterns by exchanging column by column, as shown in Fig. 2B. There are also other methods of generating a plurality of puncturing patterns such as one that combines a plurality of rows in a predetermined order.

Third Exemplary Embodiment

[0038] A third exemplary embodiment relates to an improvement of the combining unit in the receiving device of the time-diversity transmission and reception system of the first exemplary embodiment. The present system obtains a result of combining by weighting a series of depunctured data according to a level of receiving signal, and adding it symbol by symbol.

[0039] Fig. 3 shows a structure of a receiving device 310 in a time-diversity transmission and reception system of the third exemplary embodiment. A reception level memory 301 measures a level of receiving signal at a time-diversity receiver / demodulator 112 in response to a diversity reception timing control signal supplied by a diversity reception timing controller 111, and stores a result of the measurement for every diversity branch. In this example, the reception level memory 301 stores reception levels R1 and R2 for each of the time-diversity signals transmitted twice.

[0040] A weighting / combining unit 302 weights a series of depunctured data of every diversity branches delivered from a depuncturing unit 114 according to the reception level stored in the reception level memory 301, and compounds it thereafter, symbol by symbol in a unit of data block. If weighting factors for each of the

two diversity branches obtained according to magnitudes of the reception levels R1 and R2 are denoted by W1and W2, and digital values at number "i" in order of succession in the block of each series of punctured data by d1i and d2i, then a weighted-and-combined result "di" can be expressed by the following formula:

$$di = (W1 \times d1i + W2 \times d2i)/(W1 + W2)$$

[0041] The structure and function of the time-diversity transmission and reception system of this exemplary embodiment, other than the foregoing, remain the same as those of Figs. 1A and 1B.

[0042] In this embodiment, it is assumed that a magnitude of weighting is classified into three steps of "large", "medium" and "small" according to the reception level with their respective weighting factors of "1", "1/2" and "1/4", and the reception levels R1 and R2 are of magnitudes corresponding to "large" and "medium" respectively. In this instance, a weighting factor W1 for the first diversity branch becomes "1", and a weighting factor W2 for the second diversity branch becomes "1/2" at the weighting / combining unit 302. If the series of depunctured data for two diversity branches supplied from the depuncturing unit 114 are assumed to be d1 = {5, 7, -6, 0, -7, ...} and d2 = {3, -2, 0, 4, -7 ......} respectively, a series of data "d" obtained as a result of combining is d = {4.3, 4, -4, 1.3, -7 ......}, so that these data are supplied to a convolutional decoding unit 116.

[0043] Accordingly, the present exemplary embodiment of the invention is expected to achieve an effectiveness equivalent to the maximum-ratio combining diversity, since it compounds depunctured data after weighting the data according to reception levels for each diversity branch of the received time-diversity signal, when combining the depunctured data.

[0044] Although the foregoing example of the present exemplary embodiment has chosen a three-step classification for reception level with respective weighting factors of "1", "1/2" and "1/4", this is not exclusive. The classification can be set for any number of steps, and the weighting factors can be of any values so long as they correspond with the reception levels.

[0045] Also, while the foregoing exemplary embodiment has made the proportional combining calculations to include a decimal fraction in the weighting / combining unit 302, this is not restrictive, and integral calculation may be made without regarding decimal fraction.

Fourth Exemplary Embodiment

[0046] A fourth exemplary embodiment relates to a code division multiplex signal transmission and reception system for transmitting and receiving the above-cited plurality of different series of punctured data with a plurality of paths for code division multiplex signal.

[0047] Fig. 4 shows a structure of a transmission and reception system of the fourth exemplary embodiment. The system of Fig. 4 is provided with a code division multiplex signal transmitter 401 for code-division-multiplexing and transmitting a predetermined plural number of series of punctured data fed in it, in place of the diversity transmission timing controller 104 and the time-diversity modulator / transmitter 105 in the transmission device 100 of Fig. 1A. The system is also provided with a code division multiplex signal receiver 402 for receiving and demodulating individual signals transmitted with code-division-multiplexing and outputting a series of demodulated data, in place of the diversity reception timing controller 111 and the time-diversity receiver / demodulator 112 in the receiving device 110 of Fig. 1A.

[0048] The transmission and reception system constituted as above will be described hereinafter for the portions that operate differently from that of the first exemplary embodiment. The transmission device 400 transmits a plural variety of punctured data series output from a puncturing unit 103 after they are code-division-multiplexed and spread-modulated by the code division multiplex signal transmitter 401. The receiving device 410 receives the transmitted signals multiplexed by code-division multiplexing, demodulates each of the multiplexed signals with a despreading process by the code division multiplex signal receiver 402, and supplies a predetermined plural number of series of demodulated data to a depuncturing unit 114. All other operations in the Fig.4 are same as those of Figs. 1A and 1B.

[0049] As described, this exemplary embodiment of the present invention enables the system to improve quality of communication in the like manner as the one using time-diversity transmission and reception, since it carries out transmission and reception of a plurality of different series of punctured and convolution-coded data with the code division multiplexing instead of the time-diversity transmission and reception.

Fifth Exemplary Embodiment

[0050] A fifth exemplary embodiment relates to a path-diversity transmission and reception system, in which a plurality of transmission devices transmits the above-described plurality of different series of punctured data via a plurality of paths, and a receiving device receives the same.

[0051] Fig. 5 shows a structure of a transmission and reception system of the fifth exemplary embodiment. A path-diversity transmission system comprises two units of transmission devices 500a and 500b for processing and modulating identical series of information data, and transmitting them in a manner to avoid overlapping in time.

[0052] A puncturing pattern generator in each of the transmission devices is adapted to generate a puncturing pattern having the same puncturing rate but in a different form from each other. A puncturing pattern generator 502a generates a puncturing pattern that is iden-

tical to the puncturing pattern 102a in Fig. 1B, and a puncturing pattern generator 502b generates a puncturing pattern identical to the pattern 102b in the same figure.

[0053] Convolutional coding units 501a and 501b in the two transmission devices convolution-code a series of information data 521 fed in them, and output series of convolution-coded data. In the transmission device 500a, a puncturing unit 503a punctures the obtained series of convolution-coded data by using the puncturing pattern A, 102a, of Fig. 1B supplied from the puncturing pattern generator 502a. And, a puncturing unit 503b in the transmission device 500b punctures the obtained series of convolution-coded data by using the puncturing pattern B, 102b, of Fig. 1 B supplied from the puncturing pattern generator 502b. Modulator / transmitters 505a and 505b modulate and transmit the series of punctured data obtained in the foregoing puncturing units according to information for transmission timings and transmission frequencies supplied from transmission controllers 504a and 504b in the individual transmission devices. Each of the signals transmitted by the transmission devices 500a and 500b has approximately same frequency, and is so arranged not to overlap in transmission timing with each other.

[0054] A receiving device 510 receives and demodulates the signals transmitted by the two transmission devices 500a and 500b according to information for a predetermined reception timing and a receiving frequency supplied from a reception controller 511, and outputs respective series of demodulated data.

[0055] A depuncturing unit 114 depunctures the series of demodulated data of the signal transmitted by the transmission device 500a with a puncturing pattern, which is identical to the pattern 102a generated by the puncturing pattern generator 502a, out of the two predetermined forms of different puncturing patterns supplied by a multiple puncturing pattern generator 113, and the series of demodulated data of the signal transmitted by the transmission device 500b with a puncturing pattern that is identical to the pattern 102b generated by the puncturing pattern generator 502b, and outputs respective series of depunctured data.

[0056] Following the above, a compounding unit 115 compounds a plural series of the depunctured data delivered from the depuncturing unit 114, symbol by symbol in a unit of block. A convolutional decoding unit 116 then convolution-decodes the obtained series of combined results, and outputs a series of decoded information data 522.

[0057] With the present exemplary embodiment of this invention, as described above, when transmitting identical series of information data with a plurality of transmission devices, the transmission devices transmit the identical series of information data after puncturing and convolution-coding each of the data series with a different puncturing pattern among the transmission devices. A receiving device depunctures the signals transmitted by each of the transmission devices with the identical patterns that are used by the transmission devices. In this way, the invention is able to vary puncturing locations from one transmission device to another, so as to avoid a reduction in likelihood of certain information data, and to further improve quality of the communication.

[0058] Although the transmission controllers 504a and 504b in the present exemplary embodiment are so arranged that transmission frequency from each of the transmission devices are approximately equal, and their transmission timings do not overlap with each other, these are not restrictive. Instead, the transmission frequency from the transmission devices may be arranged so as not to overlap with each other, while maintaining the transmission timings approximately equal between the transmission devices. Or, both of the transmission timings and the transmission frequency can be arranged not to overlap between the transmission devices. In these cases, information for reception timings and receiving frequencies need to be set with the reception controller 511 according to the information of the transmission side.

[0059] Also, the transmission devices may be provided with code-division multiplex signal transmitters, instead of the modulator / transmitters 505a and 505b in each of the transmission devices, for modulating and transmitting the series of punctured data with code-division multiplexing according to information for transmission timing and transmission frequency, while maintaining the transmission timings and the transmission frequencies set by the transmission controllers 504a and 504b in the transmission devices approximately equal. At the same time, the receiving device comprises a code-division multiplex signal receiver, instead of the receiver / demodulator 512, for outputting a series of demodulated data by receiving and demodulating every signals transmitted with code-division multiplexing from each of the transmission devices by way of extracting them with the despreading process, while maintaining the reception timings and the reception frequencies set with the reception controller 511 for the signals transmitted by the transmission devices approximately equal. Hence a system can be constituted with a plurality of transmission devices for transmitting identical series of information data by code-division multiplexing, and a receiving device for receiving and demodulating every code-division multiplexed signals.

[0060] In addition, although the system of the present exemplary embodiment is provided with two transmission devices, this is not exclusive and three or more transmission devices can be provided, as long as puncturing patterns used by the individual transmission devices are generated in different varieties, and a multiple puncturing pattern generator in the receiving device is adapted to generate every one of these patterns. Moreover, although both of the transmission devices independently perform the entire operation between input

and transmission of the series of information data, an operation common to both devices may be made together by providing an input processing unit for processing input data.

Sixth Exemplary Embodiment

[0061] A sixth exemplary embodiment relates to a time and space diversity transmission and reception system, which transmits the above-described plurality of different series of punctured data via a plurality of paths with a same carrier wave but different in time, and receives with a plurality of receiving devices.

[0062] Fig. 6 shows a structure of a transmission and reception system of the sixth exemplary embodiment. A space diversity reception system comprises a transmission device 600 for transmitting a signal, and two units of receiving devices 610a and 610b for performing a process of receiving and demodulating the signal. In Fig. 6, the transmission device 600 is provided with a transmission controller 601 and a modulator / transmitter 602 in place of the diversity transmission timing controller 104 and the time-diversity modulator / transmitter 105 in the transmission device 100 of Figs. 1A and 1B. In the transmission device 600, an operation is carried out in the same manner as the transmission device 100 of the first exemplary embodiment between a process of convolution-coding the series of information data being transmitted and a process of puncturing them into two different series of punctured data by using two different puncturing patterns A, 102a, and B, 102b shown in Fig. 1B.

[0063] The modulator / transmitter 602 modulates and transmits one of the two different series of punctured data obtained with the puncturing pattern A, 102a, of Fig. 1B toward the receiving device 610a according to information of a predetermined transmission timing and transmission frequency for the receiving device 610a supplied from the transmission controller 601. The modulator / transmitter 602 also modulates and transmits another series of data punctured with the puncturing pattern B, 102b, of Fig. 1B toward the receiving device 610b according to the information of a predetermined transmission timing and transmission frequency for the reception device 610b supplied from the transmission controller 601. An arrangement is made in advance so that the transmission timings set for the two series of punctured data do not overlap with each other, and the transmission frequencies are approximately same.

[0064] The two units ofreceiving devices 610a and 610b receive and demodulate the signals transmitted to them from the transmission device 600 according to the information for transmission timings and transmission frequencies supplied by their respective reception controllers 611a and 611b, and output respective series of demodulated data.

[0065] In the receiving devices 610a, a depuncturing unit 614a depunctures the series of demodulated data by using the puncturing pattern A, 102a, supplied from a puncturing pattern generator 613a, and outputs a series of depunctured data 633a.

[0066] In the receiving devices 610b, on the other hand, a depuncturing unit 614b depunctures the series of demodulated data by using the puncturing pattern B, 102b, supplied from a puncturing pattern generator 613b, and outputs a series of depunctured data 633b.

[0067] An output processing device 620 accumulates the series of depunctured data 633a and 633b supplied from both of the receiving devices, and a combining unit 621 compounds them symbol by symbol in a unit of block. Then, a convolutional decoding unit 622 convolution-decodes the combined result, and outputs a series of decoded information data 632.

[0068] As has been described, the foregoing exemplary embodiment of the present invention punctures and convolution-codes a series of information data with different puncturing patterns for every transmission to the individual receiving devices when transmitting identical series of information data to the plurality of the receiving devices, thereby enabling the system to vary puncturing locations for every transmission to the individual receiving devices, prevent a degradation in likelihood of certain information data, and further improve quality of communication.

[0069] Although the transmission controller 601 in the present exemplary embodiment is so arranged in advance that transmission frequencies to the individual receiving devices are approximately equal, and their transmission timings do not overlap with each other, these are not restrictive. Instead, the transmission frequencies to the individual receiving devices may be arranged so as not to overlap between the transmissions, while maintaining the transmission timings approximately equal. Or, both of the transmission timings and the transmission frequencies can be arranged not to overlap between the transmissions to the receiving devices. In these cases, information for reception timings and receiving frequencies are to be set with the reception controllers 611a and 611b in the individual receiving devices according to information of the transmission side.

[0070] Also, the transmission devices may be provided with a code-division multiplex signal transmitter, instead of the modulator / transmitters 602, for modulating and transmitting the plurality of punctured data series with code-division multiplexing, while maintaining the transmission timings and the transmission frequencies of the transmission controller 601 approximately equal. At the same time, each of the receiving devices may comprise a code-division multiplex signal receiver, instead of the receiver / demodulators 612a and 612b, for outputting series of demodulated data by receiving and demodulating a specific signal addressed to the individual receiving devices out of the signals transmitted with code-division multiplexing from the transmission device by way of extracting it with the despreading process,

while setting the reception timings and the receiving frequencies approximately equal between the reception controllers 611a and 611b. Hence the system can be constituted with a transmission device for transmitting identical series of information data by code-division multiplexing to a plurality of receiving devices, and the receiving devices for receiving and demodulating the code-division multiplexed signals.

[0071] Furthermore, each receiving device may be provided with a reception level measuring unit for measuring individual signal levels received by the receiver / demodulator 612a or 612b according to information for the reception timing and the reception frequency supplied by the reception controller 611a or 611b, and outputting a result of the measurements. Also, the output processing device 620 may be provided with a weighting / combining unit, instead of the combining unit 621, for weighting and compounding the individual series of depunctured data based on the signal reception levels supplied by the individual receiving devices in order to gain an effectiveness equivalent to the maximum-ratio combine diversity, in the same manner as the third exemplary embodiment.

[0072] Although the system of the described embodiment is provided with two receiving devices, this is not exclusive and three or more receiving devices may be provided, if puncturing patterns to be used for puncturing during transmission to the individual receiving devices are generated in different varieties, and a multiple puncturing pattern generator in the transmission device is adapted to generate every one of these patterns.

Seventh Exemplary Embodiment

[0073] A seventh exemplary embodiment relates to a satellite-path diversity transmission and reception system, in which a transmission device transmits the above-described plurality of different series of punctured data via a plurality of paths with same carrier wave but different in time, and a receiving device receives them via a plurality of satellite repeater stations.

[0074] Fig. 7 shows a structure of a satellite-path diversity transmission and reception system of the seventh exemplary embodiment. Satellite repeater stations 700a and 700b relay transmission signals from an earth station transmission device 710 to an earth station receiving device 720. The earth station transmission device 710 is provided with an earth station modulator / transmitter 711 in place of the diversity transmission timing controller 104 and the time-diversity modulator / transmitter 105 in the transmission device100 of Figs. 1A and 1B. All other structure and operation remain same as the transmission device 100 of Figs. 1A and 1B.

[0075] Also, the earth station receiving device 720 is provided with an earth station receiver / demodulator 721 in place of the diversity reception timing controller 111 and the time-diversity receiver / demodulator 112 in the receiving device110 of Figs. 1A and 1B. All other structure and operation remain same as the receiving device 110 of Figs. 1 A and 1B.

[0076] The satellite-path diversity transmission and reception system constructed as above operates in a manner, which will be described hereinafter. In the earth station transmission device 710, a convolutional coding unit 101 convolution-codes identical series of information data at first. A puncturing unit 103 punctures the series of obtained convolution-coded data by using each of two forms of puncturing patterns A, 102a, and B, 102b, shown in Fig. 1B, supplied from a multiple puncturing pattern generator 102, and outputs two series of punctured data.

[0077] The earth station modulator / transmitter 711 modulates and transmits a series of data punctured with the puncturing pattern A, 102a, out of the two series of punctured data supplied from the puncturing unit 103 toward the satellite repeater station 700a. The earth station modulator / transmitter 711 also modulates and transmits another series of data punctured with the puncturing pattern B, 102b, toward the satellite repeater station 700b.

[0078] The earth station receiver / demodulator 721 in the earth station receiving device 720 receives and demodulates individual transmission signals relayed via the satellite repeater stations 700a and 700b, and outputs two varieties of demodulated data series.

[0079] A depuncturing unit 114 depunctures the series of demodulated data derived from a signal of the satellite repeater station 700a, out of the two series of demodulated data supplied from the earth station receiver / demodulator 721, by using a puncturing pattern, which is identical to the puncturing pattern A, 102a, supplied by a multiple puncturing pattern generator 113. The depuncturing unit 114 also depunctures another series of demodulated data derived from a signal of the satellite repeater station 700b by using a puncturing pattern that is identical to the puncturing pattern B, 102b, supplied by the multiple puncturing pattern generator 113.

[0080] A combining unit 115 compounds the two varieties of depunctured data series obtained here from symbol to symbol in a unit of block. Then, a convolutional decoding unit 116 convolution-decodes the combined result, and outputs a series of decoded information data 732.

[0081] With the present exemplary embodiment of this invention, as has been described, the earth station transmission device punctures identical series of information data by using a plurality of different puncturing patterns, and executes a satellite-path diversity transmission of the different series of obtained punctured data to a plurality of satellites as transmission data for individual satellite-path diversity branches. The earth station receiving device depunctures the transmission data by using a plurality of different puncturing patterns, which are identical to those of the transmission side, compounds and convolution-decodes thereafter. In this

way, the invention is able to avoid a degradation in likelihood of certain information data, and to further improve quality of the communication.

[0082] Although the present exemplary embodiment has a structure for making a unidirectional communication from the earth station transmission device to the earth station receiving device, this is not restrictive. In a system comprising a plurality of earth stations for performing a path-diversity transmission and reception via a plurality of satellite repeater stations, for example, each of the earth stations may comprise both of an earth station transmission device 710 and an earth station receiving device 720.

[0083] Although the system of the described embodiment is adapted to use two satellite repeater stations, this is not exclusive and three or more repeater stations can be used as is evident from the other exemplary embodiments.

[0084] Again, although the foregoing first, fourth, fifth and sixth exemplary embodiments are systems that make one-way communication from transmission devices to receiving devices, they can be systems that make bi-directional communication between two transmission / reception devices having a combined function of both transmission device and receiving device and sharing common functional components between them.

[0085] Although the transmission device in each of the foregoing exemplary embodiments has been described as having a (multiple) puncturing pattern generator and a puncturing unit as separate blocks, they can be combined into one block. For example, the puncturing unit may be adapted to generate a (or plural forms of) puncturing pattern(s), and carry out puncturing also. In the same manner, the receiving device has been described as having a (multiple) puncturing pattern generator and a depuncturing unit as separate blocks, they can be combined also into one block. For example, the depuncturing unit may be adapted to generate a (or plural forms of) puncturing pattern(s) identical to the (plural forms of) puncturing pattern(s) generated by the (multiple) puncturing pattern generator of the transmission device, and carry out depuncturing.

[0086] Accordingly, a system of the present invention convolution-codes series of information data by using puncturing patterns, which differ from one diversity branch to another, when transmitting and receiving primarily the series of information data with a combination of punctured-convolution-coding and diversity, thereby preventing a degradation in likelihood of certain information data, and achieving a remarkable improvement in quality of communication.

Claims

1. A receiver comprising:

   reception / demodulation means (112) for receiving and demodulating a signal transmitted by a transmission source (100) via a communication channel, and outputting a plurality of demodulated data series (127a, 127b);
   depuncturing means (114) for individually depuncturing said plurality of demodulated data series (127a, 127b) by using puncturing patterns (102a, 102b) that are identical to those used by said transmission source (100), and outputting a plurality of depunctured data series (128a, 128b);
   combining means (115) for combining said plurality of depunctured data series (128a, 128b), and outputting a combination result;
   convolution decoding means (116) for decoding said combination result and outputting decoded data (122);

   characterized by further comprising
   reception level memory means (301) for measuring a reception level for each of said transmitted plurality of punctured data series (126a, 126b) received by said reception / demodulation means (112), and for storing a result (R1, R2) of said measurement; and
   said combining means (302) further comprises weighting means that weight said plurality of depunctured data series (128a, 128b) according to said stored measurement results (R1, R2) before combining same.

2. A transmission and reception system comprising a transmitter (900), a receiver (110, 310) and a communication channel between said transmitter and receiver,
   said transmitter (100) comprises:

   convolution coding means (101) for convolution-coding a series of input data (121), and for outputting a convolution-coded data series (125),

   puncturing means (103) for individually puncturing said convolution-coded data series (125) by using a plurality of puncturing patterns (102a, 102b) and outputting a plurality of punctured data series (126a, 126b);

   modulation / transmission means (105) for modulating and transmitting said plurality of punctured data series (126a, 126b).

   said receiver (110, 310) comprises:

   reception / demodulation means (112) for receiving and demodulating said plurality of transmitted punctured data series, and for outputting a plurality of demodulated data series

(127a, 127b);

depuncturing means (114) for individually depuncturing said plurality of demodulated data series (127a, 127b) by using puncturing patterns (102a, 102b) that are identical to those used by said transmission source (100), and outputting a plurality of depunctured data series (128a, 128b);

combining means (115) for combining said plurality of depunctured data series (128a, 128b), and outputting a combination result;

convolution decoding means (116) for decoding said combination result and outputting decoded data (122);

characterized by
reception level memory means (301) for measuring a reception level for each of said transmitted plurality of punctured data series (126a, 126b) received by said reception / demodulation means (112), and for storing a result of said measurement; and
said combining means (115) further comprises weighting means that weight said plurality of depunctured data series (128a, 128b) according to said stored measurement results (R1, R2) before combining same.

3. The transmission and reception system according to claim 2, **characterized in that**
said modulation / transmission means (105) transmit said plurality of punctured data series (126a, 126b) via at least one communication channel;
said reception / demodulation means (112) receive said transmitted plurality of punctured data via said at least one communication channel.

4. The transmission and reception system according to claim 2 or 3, **characterized in that**
said transmitter (100) further comprises:

multiple puncturing pattern generation means (102) for generating a predetermined plurality of puncturing patterns (102a, 102b) having an identical puncturing rate, but being different in their block patterns;

diversity transmission timing control means (104) for outputting a diversity transmission timing control signal (123) for carrying out a diversity transmission at predetermined time intervals;

said transmitter (100) being **characterized in that:**

said puncturing means (103) uses each of said plurality of puncturing patterns (102a, 102b) to puncture said convolution-coded data series (125);

said modulation / transmission means (105) are time-diversity modulation / transmission means (105) that modulate and transmit said plurality of punctured data series (126a, 126b) one by one as time-diversity transmission data at predetermined intervals in response to said diversity transmission timing control signal (123);

said receiver (110, 310) further comprises:

diversity reception timing control means (111) for outputting a predetermined diversity reception timing control signal for carrying out reception of a time-diversity transmission signal of the transmitter at said predetermined intervals;

multiple puncturing pattern generation means (113) for generating puncturing patterns (102a, 102b), which are identical to the predetermined plurality of puncturing patterns (102a, 102b) of the receiver (100);

said receiver (110, 310) being **characterized in that**:

said reception / demodulation means (112) are time-diversity reception / demodulation means (112) for receiving and demodulating said time-diversity transmission signal of the transmitter;

said depuncturing means (114) depuncture each of the plurality of punctured data series (126a, 126b) received and demodulated by said time-diversity reception / demodulation means (112) using said plurality of puncturing patterns (102a, 102b) supplied by said multiple

puncturing pattern generation means (113) of the receiver.

5. The transmission and reception system according to claim 4, **characterized in that**
said demodulated data series (127a, 127b) output by said time-diversity reception / demodulation means (112) are digital values quantized with a predetermined number of bits;
said depuncturing process carried out by said first depuncturing means (114) inserts a middle value between two digital values corresponding to a mark and a space;
said combining process carried out by said combining means (115) adds a digital value to each symbol in a unit block of said plurality of depunctured data series (128a, 128b); and

said convolution decoding means (116) contains Viterbi soft quantization means for executing Viterbi soft decision.

6. The transmission and reception system according to claim 4 or 5, **characterized in that** puncturing locations in said predetermined plurafity of puncturing patterns (102a, 102b) are set in advance such that said puncturing locations do not overlap in said plurality of patterns.

7. The transmission and reception system according to one of claims 4 to 6, **characterized in that** said multiple puncturing pattern generation means (102, 113) in the receiver and the transmitter each comprise:

    reference matrix generation means (201) for generating a reference matrix of puncturing patterns (102a, 102b), and

    matrix conversion means (202) for outputting a different puncturing pattern for each diversity branch by converting any one or more of rows, columns and elements of said reference matrix.

8. The transmission and reception system according to one of claims 3 to 7, **characterized in that** said transmitter (400) comprises multiple puncturing pattern generation means (102) for generating a predetermined plurality of puncturing patterns (102a, 102b) having an identical puncturing rate, but being different in their block patterns;
said modulation / transmission means (105) is a code division multiplex signal transmission means (401) for transmitting said plurality of punctured data series (126a, 126b) and transmits same simultaneously;
said receiver (410) comprises comprises multiple puncturing pattern generation means (113) for generating a predetermined plurality of puncturing patterns (102a, 102b), which are identical to the plurality of puncturing patterns (102a, 102b) generated by the multiple puncturing pattern generation means (102) of the transmitter (400); and
said reception / demodulation means (112) are code division multiplex signal reception means (402) for receiving and demodulating said plurality of transmitted punctured data series and outputting a plurality of demodulated data series (127a, 127b).

9. The transmission and reception system according to one of claims 4 to 8, **characterized in that** said transmitter is a transmission earth station (710) of a satellite-channel transceiver system;
said receiver is a receiving earth station (720) of a satellite transceiver system; and
said transmission and reception system further comprises a plurality of repeater stations (700a, 700b) that receive the convolution-coded and punctured data series transmitted by said a transmission earth station (710) and propagate the convolution-coded and punctured data series to said receiving earth station (720).

10. The transmission and reception system according to one of claims 3 to 9, **characterized in that** said transmission and reception system comprises a plurality of earth stations (710, 720) communicating with one another via said plurality of satellite repeater stations (700a, 700b); each earth station comprising a transmission earth station and a receiving earth station.

11. A transmission and reception system comprising a plurality of transmitters (500a, 500b) for transmitting series of identical information data (521), and a receiver (510) for receiving a plurality of signals transmitted by said transmitters (500a, 500b), each of said plurality of transmitters comprising:

    convolution coding means (501 a, 501 b) for convolution-coding and outputting said series of identical information input data (521);

    puncturing pattern generation means (502a, 502b) for generating a puncturing pattem;

    puncturing means (503a, 503b) for puncturing a convolution-coded data series (125) output by said convolution coding means (501a, 501b) by using the puncturing pattern from said puncturing pattern generation means (502a, 502b), and outputting a punctured data series;

    transmission control means (504a, 504b) for outputting a predetermined transmission timing and a predetermined transmission frequency to said transmitter to control a transmission; and

    a first modulation / transmission means (505a, 505b) for modulating and transmitting said punctured data series in response to said transmission timing and transmission frequency;

said receiver (510) comprising:

    reception control means (511) for outputting a predetermined reception timing and a predetermined reception frequency to control a reception process;

    reception / demodulation means (512) for receiving and demodulating said plurality of punctured data series (126a, 126b) of said plurality of transmitters in response to said predeter-

mined reception timing and said predetermined reception frequency, and for outputting individual demodulated data series (127a, 127b);

multiple puncturing pattern generation means (113) for generating a plurality of puncturing patterns (102a, 102b);

depuncturing means (114) for depuncturing each of the demodulated data series (127a, 127b) and outputting individual depunctured data series (128a, 128b);

combining means (115) for combining each symbol in a unit block said plural depunctured data series (128a, 128b), and outputting a combination result; and

convolution decoding means (116) for convolution-decoding said combination result,

characterized in that
said generated puncturing patterns (102a, 102b), generated in by said puncturing pattern generation means (502a, 502b) of said plurality of transmitters, have an identical puncturing rate, but are different in their block patterns;
said reception control means (511) control the reception of said plurality of punctured data series (126a, 126b) transmitted by said plurality of transmitters;
said reception / demodulation means (512) receive and demodulate said plurality of punctured data series (126a, 126b) transmitted by each of said transmitters;
said puncturing patterns (102a, 102b), generated by said multiple puncturing pattern generation means (113) of said receiver, are identical to the individual puncturing patterns (102a, 102b) of said plurality of transmitters (500a, 500b);
said depuncturing means (114) depuncture each of the demodulated data series (127a, 127b) by using a puncturing pattern that is identical to the one used by said respective transmitter to puncture the respective data; and
said transmission and reception system sets said transmission frequencies approximately equal and selects said transmission timings in advance such that the transmission timings of said plurality of transmitters do not overlap with each other, and each transmitter transmits said convolution-coded and, with different puncturing patterns (102a, 102b), punctured series of identical information data at a different timing.

12. The transmission and reception system according to claim 9, **characterized in that**
said transmission control means (504a, 504b) sets transmission timings approximately equal and selects said transmission frequencies in advance such that the transmission frequencies of said plurality of transmitters do not overlap with each other; and
said reception control means (511) sets reception timings and reception frequencies in advance and to correspond to said transmission timings and said transmission frequencies of said plurality of transmitters.

13. The transmission and reception system according to claim 9, **characterized in that**
said transmission control means (504a, 504b) sets transmission timings and transmission frequencies in advance such that the transmission timings and the transmission frequencies of said plurality of transmitters do not overlap with each other, and
said reception control means (511) sets reception timings and reception frequencies in advance and to correspond to said transmission timings and said transmission frequencies of said transmission control means.

14. The transmission and reception system according to claim 11, wherein:

said transmission control means (504a, 504b) sets transmission timings and transmission frequencies in advance and to be approximately equal among said plurality of transmitters;

said modulation / transmission means (505a, 505b) is a code division multiplex signal transmission means for transmitting said plurality of punctured data series (126a, 126b);

said reception control means (511) in said reception device sets reception timings and reception frequencies in advance and to correspond with said transmission timings and said transmission frequencies of said transmission control means; and

said reception / demodulation means (512) are code division multiplex signal reception means for receiving and demodulating said transmitted convolution-coded and, with different puncturing patterns (102a, 102b), punctured series of identical information data and outputting a plurality of demodulated data series (127a, 127b).

15. A transmission and reception system comprising a transmitter (600), a plurality of receivers (610a, 610b) for receiving a signal output by said transmitter,
said transmitter (600) comprising:

convolution coding means (101) for outputting a series of input data (631) by convolution-coding said series of data;

multiple puncturing pattern generation means (102) for generating and outputting a predetermined plurality of puncturing patterns (102a, 102b) having an identical puncturing rate, but different in their block pattern;

puncturing means (103) for puncturing said convolution-coded data series (125) by using each of said predetermined plurality of puncturing patterns (102a, 102b), and outputting a predetermined plurality of different punctured data series;

transmission control means (601) for outputting a predetermined transmission timing and a predetermined transmission frequency for said transmitter, and

modulation / transmission means (602) for modulating and transmitting each of said plurality of different punctured data series in response to said transmission timing and said transmission frequency,

each of said plurality of receivers (610a, 610b) comprising:

reception control means (611a, 611b) for outputting a predetermined transmission timing and a predetermined transmission frequency to control a reception process;
reception / demodulation means (612a, 612b) for receiving and demodulating a transmitted punctured data series according to said predetermined reception timing and said predetermined reception frequency, and outputting a demodulated data series;
puncturing pattern generation means (613a, 613b) for generating a puncturing pattern; and depuncturing means (614a, 614b) for depuncturing said demodulated data series by using said puncturing pattern supplied by said puncturing pattern generation means (613a, 613b), and outputting a depunctured data series (128a, 128b), and

characterized in that
said puncturing pattern generation means (613a, 613b) in said plurality of receivers (610a, 610b) generate a puncturing pattern which is identical to the puncturing pattern used to puncture the punctured data series the respective receiver is receiving;
said transmission timing in the transmitter (600) is such that the individual transmissions of the individual punctured data series do not overlap, and
said transmission frequency in the transmitter is approximately equal among said individual transmissions.
the transmission and reception system further comprises an output processing device (620) for accumulating series of data received in said plurality of receivers, said output processing device comprising:

combining means (621) for combining each symbol in a unit blocks in said depunctured data series (633a, 633b) obtained from each of said plurality of receivers and outputting a combination result;

convolution decoding means (622) for convolution-decoding said combination result;

16. The transmission and reception system according to claim 13, **characterized in that**
said transmission control means (601) sets said individual transmission timings approximately equal and selects said transmission frequencies in advance such that the transmission frequencies do not overlap; and
said reception control means (611a, 611b) sets reception timings and reception frequencies for each receiver (610a, 610b) in advance and to correspond to said transmission timings and said transmission frequencies of said transmission control means (601).

17. The transmission and reception system according to claim 13, **characterized in that**
said transmission control means (601) sets transmission timings and transmission frequencies in advance such that the transmission timings and the transmission frequencies do not overlap; and
said reception control means (611 a, 611 b) sets reception timings and reception frequencies for each receiver in advance and to correspond to said transmission timings and said transmission frequencies of said transmission control means (601).

18. (16) The transmission and reception system according to claim 15, **characterized in that**
said transmission control means (601) sets transmission timings and transmission frequencies in advance and to be approximately equal;
said modulation / transmission means (602) is a code division multiplex signal transmission means for transmitting said plurality of punctured data series (126a, 126b);
said reception control means (611 a, 611 b) in said reception device sets reception timings and reception frequencies for each receiver in advance and to correspond with said transmission timings and

said transmission frequencies of said transmission control means (601); and
said reception / demodulation means (612a, 612b) are code division multiplex signal reception means for receiving and demodulating said transmitted convolution-coded and, with different puncturing patterns (102a, 102b), punctured series of identical information data and outputting a plurality of demodulated data series.

19. A method for reception comprising the steps of:

receiving and demodulating a signal transmitted via a communication channel, and outputting a plurality of demodulated data series (127a, 127b);
depuncturing said plurality of demodulated data series (127a, 127b) by using puncturing patterns (102a, 102b) that are identical to said plurality of puncturing patterns (102a, 102b) used in said step of puncturing, and outputting a plurality of depunctured data series (128a, 128b);
combining said plurality of depunctured data series (128a, 128b), and outputting a combination result; and
convolution-decoding said combination result, and outputting a decoded data (122).

characterized in that
the step of combining includes the step of weighting, which weights each of said transmitted plurality of depunctured data series (128a, 128b) according to the reception level of each of said transmitted plurality of punctured data series (126a, 126b) before the plurality of depunctured data series (128a, 128b) are combined.

Patentansprüche

1. Empfänger, der umfasst:

eine Empfangs-/Demodulationseinrichtung (112), die ein Signal empfängt und demoduliert, das von einer Sendequelle (100) über ein Kommunikationssignal gesendet wird, und eine Vielzahl demodulierter Datenreihen (127a, 127b) ausgibt;

eine Depunktiereinrichtung (114), die die Vielzahl demodulierter Datenreihen (127a, 127b) unter Verwendung von Punktiermustern (102a, 102b), die identisch mit denen sind, die durch die Sendequelle (100) verwendet werden, einzeln depunktiert und eine Vielzahl depunktierter Datenreihen (128a, 128b) ausgibt;

eine Kombiniereinrichtung (115), die die Vielzahl depunktierter Datenreihen (128a, 128b) kombiniert und ein Kombinationsergebnis ausgibt;

eine Faltungsdecodiereinrichtung (116), die das Kombinationsergebnis decodiert und decodierte Daten (122) ausgibt;

dadurch gekennzeichnet, dass er des Weiteren umfasst:

eine Empfangspegel-Speichereinrichtung (301), die einen Empfangspegel für jede der gesendeten Vielzahl punktierter Datenreihen (126a, 126b), die von der Empfangs-/Demodulationseinrichtung (112) empfangen werden, misst und ein Ergebnis (R1, R2) der Messung speichert; und

wobei die Kombiniereinrichtung (302) des Weiteren eine Wichtungseinrichtung umfasst, die die Vielzahl depunktierter Datenreihen (128a, 128b) entsprechend der gespeicherten Messergebnisse (R1, R2) wichtet, bevor sie diese kombiniert.

2. Sende-und-Empfangs-System, das einen Sender (100), einen Empfänger (110, 310) und einen Kommunikationskanal zwischen dem Sender und dem Empfänger umfasst,
wobei der Sender (100) umfasst:

eine Faltungscodiereinrichtung (101), die Faltungscodierung einer Reihe von Eingabedaten (121) durchführt und eine faltungscodierte Datenreihe (125) ausgibt,

eine Punktiereinrichtung (103), die die faltungscodierten Datenreihen (125) unter Verwendung einer Vielzahl von Punktiermustern (120a, 102 b) einzeln punktiert und eine Vielzahl punktierter Datenreihen (126a, 126b) ausgibt;

eine Modulations-/Sendeeinrichtung (105), die die Vielzahl punktierter Datenreihen (126a, 126b) moduliert und sendet,

wobei der Empfänger (110, 310) umfasst:

eine Empfangs-/Demodulationseinrichtung (112), die die Vielzahl gesendeter punktierter Datenreihen empfängt und demoduliert und eine Vielzahl demodulierter Datenreihen (127a, 127b) ausgibt;

eine Depunktiereinrichtung (114), die die Vielzahl demodulierter Datenreihen (127a, 127b) unter Verwendung von Punktiermustern (102a,

102b), die identisch mit denen sind, die durch die Sendequelle (100) verwendet werden, einzeln depunktiert und eine Vielzahl depunktierter Datenreihen (128a, 128b) ausgibt;

eine Kombiniereinrichtung (115), die die Vielzahl depunktierter Datenreihen (128a, 128b) kombiniert und ein Kombinationsergebnis ausgibt;

eine Faltungsdecodiereinrichtung (116), die das Kombinationsergebnis decodiert und decodierte Daten (122) ausgibt;

gekennzeichnet durch:

eine Empfangspegel-Speichereinrichtung (301), die einen Empfangspegel für jede der gesendeten Vielzahl punktierter Datenreihen (126a, 126b), die von der Empfangs-/Demodulationseinrichtung (112) empfangen werden, misst und ein Ergebnis der Messung speichert; und

wobei die Kombiniereinrichtung (115) des Weiteren eine Wichtungseinrichtung umfasst, die die Vielzahl depunktierter Datenreihen (128a, 128b) entsprechend der gespeicherten Messergebnisse (R1, R2) wichtet, bevor sie diese kombiniert.

3. Sende-und-Empfangs-System nach Anspruch 2, **dadurch gekennzeichnet, dass**:

die Modulations-/Sendeeinrichtung (105) die Vielzahl punktierter Datenreihen (126a, 126b) über wenigstens einen Kommunikationssignal sendet;

wobei die Empfangs-/Demodulationseinrichtung (112) die gesendete Vielzahl punktierter Daten über den wenigstens einen Kommunikationssignal empfängt.

4. Sende-und-Empfangs-System nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass**:

der Sender (100) des Weiteren umfasst:

mehrere Punktiermuster-Erzeugungseinrichtungen (102), die eine vorgegebene Vielzahl von Punktiermustern (102a, 102b) erzeugen, die eine identische Punktierrate haben, sich jedoch hinsichtlich ihrer Blockmuster unterscheiden;

eine Diversitysende-Zeitsteuereinrichtung (104), die ein Diversitysende-Zeitsteuersignal (123) ausgibt, um ein Diversitysenden in vorgegebenen Zeitintervallen auszuführen;

wobei der Sender (100) **dadurch gekennzeichnet ist, dass**:

die Punktiereinrichtung (103) jedes der Vielzahl von Punktiermustern (102a, 102b) verwendet, um die faltungscodierten Datenreihen (125) zu punktieren;

die Modulations-/Sendeeinrichtung (105) eine Zeitdiversity-Modulations-/Sendeeinrichtung (105) ist, die in Reaktion auf das Diversitysende-/Zeitsteuersignal (123) die Vielzahl punktierter Datenreihen (126a, 126b) nacheinander als Zeitdiversity-Sendedaten moduliert und sendet;

wobei der Empfänger (110, 310) des Weiteren umfasst:

eine Diversityempfangs-Zeitsteuereinrichtung (111), die ein vorgegebenes Diversityempfangs-Zeitsteuersignal ausgibt, um Empfang eines Zeitdiversity-Sendesignals des Senders in den vorgegebenen Intervallen auszuführen;

mehrere Punktiermuster-Erzeugungseinrichtung (113), die Punktiermuster (102a, 102b) erzeugen, die mit der vorgegebenen Vielzahl von Punktiermustern (102a, 102b) des Empfängers (100) identisch sind;

wobei der Empfänger (110, 310) **dadurch gekennzeichnet ist, dass**:

die Empfangs-/Demodulationseinrichtung (112) eine Zeitdiversity-Empfangs-/Demodulationseinrichtung (112) ist, die das Zeitdiversity-Sendesignal des Senders empfängt und demoduliert;

die Depunktiereinrichtung (114) jede der Vielzahl punktierter Datenreihen (126a, 126b), die durch die Zeitdiversity-Empfangs-/Demodulationseinrichtung (112) empfangen und demoduliert werden, unter Verwendung der Vielzahl von Punktiermustern (102a, 102b), die durch die mehreren Punktiermuster-Erzeugungseinrichtungen (113) des Empfängers zugeführt werden, depunktiert.

5. Sende-und-Empfangs-System nach Anspruch 4, **dadurch gekennzeichnet, dass**:

die demodulierte Datenreihen (127a, 127b), die von der Zeitdiversity-Empfangs/Demodulati-

onseinrichtung (112) ausgegeben werden, digitale Werte sind, die mit einer vorgegebenen Anzahl von Bits quantisiert sind;

bei dem Depunktiervorgang, der durch die erste Depunktiereinrichtung (114) ausgeführt wird, ein mittlerer Wert zwischen zwei digitale Werte eingefügt wird, die einem einem Zeichen und einer Leerstelle entsprechen;

bei dem Kombiniervorgang, der durch die Kombiniereinrichtung (115) ausgeführt wird, zu jedem Symbol in einer Blockeinheit der Vielzahl depunktierter Datenserien (128a, 128b) ein digitaler Wert hinzugefügt wird, und

die Faltungsdecodiereinrichtung (116) eine Viterbi-Weichquantifizierungseinrichtung zum Durchführen von Viterbi-Weichentscheidung enthält.

6. Sende-und-Empfangs-System nach Anspruch 4 oder 5, **dadurch gekennzeichnet, dass** Punktierpositionen in der vorgegebenen Vielzahl von Punktiermustem (102a, 102b) im Voraus so festgelegt werden, dass sich die Punktierpositionen in der Vielzahl von Mustern nicht überlappen.

7. Sende-und-Empfangs-System nach einem der Ansprüche 4 bis 6, **dadurch gekennzeichnet, dass** die mehreren Punktiermuster-Erzeugungseinrichtungen (112, 113) in dem Empfänger und dem Sender jeweils umfassen:

eine Bezugsmatrix-Erzeugungseinrichtung (201), die eine Bezugsmatrix von Punktiermustern (102a, 102b) erzeugt, und

eine Matrix-Umwandlungseinrichtung (202), die ein anderes Punktiermuster für jeden Diversityzweig ausgibt, in dem sie eine oder mehrere Reihen, Spalten und Elemente der Bezugsmatrix umwandelt.

8. Sende-und-Empfangs-System nach einem der Ansprüche 3 bis 7, **dadurch gekennzeichnet, dass**:

der Sender (400) mehrere Punktiermuster-Erzeugungseinrichtungen (102) umfasst, die eine vorgegebene Vielzahl von Punktiermustern (102a, 102b) erzeugen, die eine identische Punktierrate haben, sich jedoch hinsichtlich ihrer Blockmuster unterscheiden;

die Modulier-/Sendeeinrichtung (105) eine Codemultiplex-Signalsendeeinrichtung (401) ist, die die Vielzahl punktierter Datenreihen (126a, 126b) sendet und diese gleichzeitig sendet;

der Empfänger (410) mehrere Punktiermuster-Erzeugungseinrichtungen (113) umfasst, die eine vorgegebene Vielzahl von Punktiermustern (102a, 102b) erzeugen, die mit der Vielzahl von Punktiermustern (102a, 102b) identisch sind, die durch die mehreren Punktiermuster-Erzeugungseinrichtungen (102) des Senders (400) erzeugt werden; und

die Empfangs-/Demoduliereinrichtung (112) eine Codemultiplex-Signalempfangseinrichtung (402) ist, die die Vielzahl gesendeter punktierter Datenreihen empfängt und demoduliert und eine Vielzahl demodulierter Datenreihen (127a, 127b) ausgibt.

9. Sende-und-Empfangs-System nach einem der Ansprüche 4 bis 8, **dadurch gekennzeichnet, dass**:

der Sender eine Sende-Erdstation (710) eines Satellitenkanal-Sender-Empfänger-Systems ist;

der Empfänger eine Empfangs-Erdstation (720) eines Satelliten-Sender-Empfänger-Systems ist; und

das Sende-und-Empfangs-System des Weiteren eine Vielzahl von Zwischenverstärkerstationen (700a, 700b) umfasst, die die faltungscodierten und punktierten Datenreihen empfangen, die von einer Sende-Erdstation (710) gesendet werden, und die faltungscodierten und punktierten Datenreihen zu der Empfangs-Erdstation (720) weiterleiten.

10. Sende-und-Empfangs-System nach einem der Ansprüche 3 bis 9, **dadurch gekennzeichnet, dass**:

das Sende-und-Empfangs-System eine Vielzahl von Erdstationen (710, 720) umfasst, die miteinander über die Vielzahl von Satelliten-Zwischenverstärkerstationen (700a, 700b) kommunizieren, wobei jede Erdstation eine Sende-Erdstation und eine Empfangs-Erdstation umfasst.

11. Sende-und-Empfangs-System, das eine Vielzahl von Sendern (500a, 500b), die Reihen identischer Informationsdaten (521) senden, und einen Empfänger (510), der eine Vielzahl von Signalen empfängt, die von den Sendern (500a, 500b) gesendet werden, umfasst, wobei jeder der Vielzahl von Sendern umfasst:

eine Faltungscodiereinrichtung (501 a, 501 b), die Faltungscodierung der Reihe identischer Informationseingabedaten (521) durchführt

und sie ausgibt;

eine Punktiermuster-Erzeugungseinrichtung (502a, 502b), die ein Punktiermuster erzeugt;

eine Punktiereinrichtung (503a, 503b), die eine faltungscodierte Datenreihe (125), die von der Faltungscodiereinrichtung (501 a, 501 b) ausgegeben wird, unter Verwendung des Punktiermusters von der Punktiermuster-Erzeugungseinrichtung (502a, 502b) punktiert und eine punktierte Datenreihe ausgibt;

eine Sendesteuereinrichtung (504a, 504b), die eine vorgegebene Sendezeit und eine vorgegebene Sendefrequenz an den Sender ausgibt, um ein Senden zu steuern; und

eine erste Modulations-/Sendeeinrichtung (505a, 505b), die in Reaktion auf die Sendezeit und die Sendefrequenz die punktierte Datenreihe moduliert und sendet;

wobei der Empfänger (510) umfasst:

eine Sendesteuereinrichtung (511), die eine vorgegebene Empfangszeit und eine vorgegebene Empfangsfrequenz ausgibt, um einen Empfangsvorgang zu steuern;

eine Empfangs-/Demodulationseinrichtung (512), die in Reaktion auf die vorgegebene Empfangszeit und die vorgegebene Empfangsfrequenz die Vielzahl punktierter Datenreihen (126a, 126b) der Vielzahl von Sendern empfängt und demoduliert und einzelne demodulierte Datenreihen (127a, 127b) ausgibt;

mehrere Punktiermuster-Erzeugungseinrichtungen (113), die eine Vielzahl von Punktiermustern (102a, 102b) erzeugen;

eine Depunktiereinrichtung (114), die jede der demodulierten Datenreihen (127a, 127b) depunktiert und einzelne depunktierte Datenreihen (128a. 129b) ausgibt;

eine Kombiniereinrichtung (115), die jedes Symbol in einer Blockeinheit der mehreren Datenreihen (128a, 128b) kombiniert und ein Kombinationsergebnis ausgibt; und

eine Faltungsdecodiereinrichtung (116), die Faltungsdecodierung des Kombinationsergebnisses durchführt,

dadurch gekennzeichnet, dass:

die erzeugten Punktiermuster (102a, 102b), die durch die Punktiermuster-Erzeugungseinrichtungen (502a, 502b) der Vielzahl von Sendern erzeugt werden, eine identische Punktierrate haben, sich jedoch hinsichtlich ihrer Blockmuster unterscheiden;

die Empfangssteuereinrichtung (511) den Empfang der Vielzahl punktierter Datenreihen (126a, 126b) steuert, die durch die Vielzahl von Sendern gesendet werden;

die Empfangs-/Demodulationseinrichtung (512), die Vielzahl punktierter Datenreihen (126a, 126b), die durch jeden der Sender gesendet werden, empfängt und demoduliert;

die Punktiermuster (102a, 102b), die durch die mehreren Punktiermuster-Erzeugungseinrichtungen (113) des Empfängers erzeugt werden, mit den einzelnen Punktiermustern (102a, 102b) der Vielzahl von Sendern (500a, 500b) identisch sind;

die Depunktiereinrichtung (114) jede der demodulierten Datenreihen (127a, 127b) unter Verwendung eines Punktiermusters depunktiert, das mit dem identisch ist, das durch den entsprechenden Sender zum Punktieren der entsprechenden Daten verwendet wird; und

das Sende-und-Empfangs-System die Sendefrequenzen annähernd gleich einstellt und die Sendezeiten im Voraus so auswählt, dass die Sendezeiten der Vielzahl von Sendern einander nicht überlappen, und jeder Sender die faltungscodierten und mit verschiedenen Punktiermustern (102a, 102b) punktierten Reihen identischer Informationsdaten zu einer anderen Zeit sendet.

12. Sende-und-Empfangs-System nach Anspruch 9, **dadurch gekennzeichnet, dass**:

die Sendesteuereinrichtung (504a, 504b) Sendezeiten annähernd gleich einstellt und die Sendefrequenzen im Voraus so auswählt, dass die Sendefrequenzen der Vielzahl der Sender einander nicht überlappen; und

die Empfangssteuereinrichtung (511) Empfangszeiten und Empfangsfrequenzen im Voraus einstellt, so dass sie den Sendezeiten und den Sendefrequenzen der Vielzahl von Sendern entsprechen.

13. Sende-und-Empfangs-System nach Anspruch 9, **dadurch gekennzeichnet, dass**:

die Sendesteuereinrichtung (504a, 504b) Sendezeiten und Sendefrequenzen im Voraus so einstellt, dass die Sendezeiten und die Sendefrequenzen der Vielzahl von Sendern einander nicht überlappen; und
die Empfangssteuereinrichtung (511) Empfangszeiten und Empfangsfrequenzen im Voraus so einstellt, dass sie den Sendezeiten und den Sendefrequenzen der Sendesteuereinrichtung entsprechen.

14. Sende-und-Empfangs-System nach Anspruch 11, wobei:

die Sendesteuereinrichtung (504a, 504b) Sendezeiten und Sendefrequenzen im Voraus einstellt, so dass sie einander unter der Vielzahl von Sendern gleich sind;

die Modulations-/Sendeeinrichtung (505a, 505b) eine Codemultiplex-Signalsendeeinrichtung ist, die die Vielzahl punktierter Datenreihen (126a, 126b) sendet;

die Empfangssteuereinrichtung (511) in der Empfangsvorrichtung Empfangszeiten und Empfangsfrequenzen im Voraus einstellt, so dass sie den Sendezeiten und den Sendefrequenzen der Sendesteuereinrichtung entsprechen; und

die Empfangs-/Demodulationseinrichtung (512) eine Codemultiplex-Signalempfangseinrichtung ist, die die gesendeten faltungscodierten und mit verschiedenen Punktiermustern (102a, 102b) punktierten Reihen identischer Informationsdaten empfängt und demoduliert und eine Vielzahl demodulierter Datenreihen (127a, 127b) ausgibt.

15. Sende-und-Empfangs-System, das einen Sender (600), eine Vielzahl von Empfängern (610a, 610b), die ein von dem Sender ausgegebenes Signal empfangen, umfasst,
wobei der Sender (600) umfasst:

eine Faltungscodiereinrichtung (101), die ei ne Reihe von Eingabedaten (631) ausgibt, indem sie Faltungscodierung der Reihe von Daten durchführt;

mehrere Punktiermuster-Erzeugungseinrichtungen (102), die eine vorgegebene Vielzahl von Punktiermustern (102a, 102b) erzeugen und ausgeben, die eine identische Punktierrate haben, sich jedoch hinsichtlich ihres Blockmusters unterscheiden;

eine Punktiereinrichtung (103), die die faltungscodierten Datenreihen (125) unter Verwendung jedes der vorgegebenen Vielzahl von Punktiermustern (102a, 102b) punktiert und eine vorgegebene Vielzahl verschiedener punktierter Datenreihen ausgibt;

eine Sendesteuereinrichtung (601), die eine vorgegebene Sendezeit und eine vorgegebene Sendefrequenz für den Sender ausgibt; und

eine Modulations-/Sendeeinrichtung (602), die in Reaktion auf die Sendezeit und die Sendefrequenz jede der Vielzahl verschiedener punktierter Datenreihen moduliert und sendet,

wobei jeder der Vielzahl von Empfängern (610a, 610b) umfasst:

eine Empfangssteuereinrichtung (611a, 611 b), die eine vorgegebene Sendezeit und eine vorgegebene Sendefrequenz ausgibt, um einen Empfangsvorgang zu steuern;

eine Empfangs-/Demodulationseinrichtung (612a, 612b), die eine gesendete punktierte Datenreihe entsprechend der vorgegebenen Empfangszeit und der vorgegebenen Empfangsfrequenz empfängt und demoduliert und eine demodulierte Datenreihe ausgibt;

eine Punktiermuster-Erzeugungseinrichtung (613a, 613b), die ein Punktiermuster erzeugt; und

eine Depunktiereinrichtung (614a, 614b), die die demodulierte Datenreihe unter Verwendung des Punktiermusters, das von der Punktiermuster-Erzeugungseinrichtung (613a, 613b) zugeführt wird, depu nktiert und eine depunktierte Datenreihe (128a, 128b) ausgibt, und

dadurch gekennzeichnet, dass:

die Punktiermuster-Erzeugungseinrichtungen (613a, 613b) in der Vielzahl von Empfängern (610a, 610b) ein Punktiermuster erzeugen, das mit dem Punktiermuster identisch ist, das verwendet wird, um die punktierte Datenreihe zu punktieren, die der jeweilige Empfänger empfängt;

die Sendezeit in dem Sender (600) so ist, dass sich die einzelnen Sendevorgänge der einzelnen punktierten Datenreihen nicht überlappen, und

die Sendefrequenz in dem Sender unter den einzelnen Sendevorgängen annähernd gleich ist,

das Sende-und-Empfangs-System des Weiteren eine Ausgabe-Verarbeitungseinrichtung (620) umfasst, die Reihen von Daten, die in der Vielzahl von Empfängern empfangen werden, akkumuliert, wobei die Ausgabe-Verarbeitungsvorrichtung umfasst:

eine Kombiniereinrichtung (621), die jedes Symbol in einer Blockeinheit in der depunktierten Datenreihe (633a, 633b), die von jedem der Vielzahl von Empfängern gewonnen wird, kombiniert und ein Kombinationsergebnis ausgibt,

eine Faltungsdecodiereinrichtung (622), die Faltungsdecodierung des Kombinationsergebnisses durchführt.

16. Sende-und-Empfangs-System nach Anspruch 13, **dadurch gekennzeichnet, dass:**

die Sendesteuereinrichtung (601) die einzelnen Sendezeiten annähernd gleich einstellt und die Sendefrequenzen im Voraus so auswählt, dass sich die Sendefrequenzen nicht überlappen; und

die Empfangssteuereinrichtung (611 a, 611 b) Empfangszeiten und Empfangsfrequenzen für jeden Empfänger (610a, 610b im Voraus so einstellt, dass sie den Sendezeiten und den Sendefrequenzen der Sendesteuereinrichtung (601) entsprechen.

17. Sende-und-Empfangs-System nach Anspruch 13, **dadurch gekennzeichnet, dass:**

die Sendesteuereinrichtung (601) Sendezeiten und Sendefrequenzen im Voraus so einstellt, dass sich die Sendezeiten und die Sendefrequenzen nicht überlappen; und

die Empfangssteuereinrichtung (611a, 611b) Empfangszeiten und Empfangsfrequenzen für jeden Empfänger im Voraus so einstellt, dass sie den Sendezeiten und den Sendefrequenzen der Sendesteuereinrichtungen (601) entsprechen.

18. Sende-und-Empfangs-System nach Anspruch 15, **dadurch gekennzeichnet, dass:**

die Sendesteuereinrichtung (601) Sendezeiten und Sendefrequenzen im Voraus so einstellt, dass sie annähernd gleich sind;

die Modulations-/Sendeeinrichtung (602) eine Codemultiplex-Signalsendeeinrichtung ist, die die Vielzahl punktierter Datenreihen (126a, 126b) sendet;

die Empfangssteuereinrichtung (611a, 611b) in der Empfangsvorrichtung Empfangszeiten und Empfangsfrequenzen für jeden Empfänger im Voraus so einstellt, dass sie den Sendezeiten und den Sendefrequenzen der Sendesteuereinrichtung (601) entsprechen; und

die Empfangs-/Demoduliereinrichtung (612a, 612b) eine Codemultiplex-Signalempfangsvorrichtung ist, die die gesendeten faltungscodierten und mit verschiedenen Punktiermustern (102a, 102b) punktierten Reihen identischer Informationsdaten empfängt und demoduliert und eine Vielzahl demodulierter Datenreihen ausgibt.

19. Verfahren zum Empfangen, das die folgenden Schritte umfasst:

Empfangen und Demodulieren eines Signals, das über einen Kommunikationskanal gesendet wird, und Ausgeben einer Vielzahl demodulierter Datenreihen (127a, 127b);

Depunktieren der Vielzahl demodulierter Datenreihen (127a, 127b) unter Verwendung von Punktiermustern (102a, 102b), die mit der Vielzahl von Punktiermustern (102a, 102b) identisch sind, die beim Schritt des Punktierens verwendet werden, und Ausgeben einer Vielzahl depunktierter Datenreihen (128a, 128b);

Kombinieren der Vielzahl depunktierter Datenreihen (128a, 128b) und Ausgeben eines Kombinationsergebnisses; und

Faltungscodieren des Kombinationsergebnisses und Ausgeben decodierter Daten (122),

dadurch gekennzeichnet, dass:

der Schritt des Kombinierens den Schritt des Wichtens einschließt, bei dem jede der gesendeten Vielzahl punktierter Datenreihen (128a, 128b) entsprechend dem Empfangspegel jeder der gesendeten Vielzahl punktierter Datenreihen (126a, 126b) gewichtet wird, bevor die Vielzahl depunktierter Datenreihen (128a, 128b) kombiniert werden.

Revendications

1. Récepteur comprenant :

   un moyen de réception/démodulation (112) destiné à recevoir et à démoduler un signal émis par une source d'émission (100) par l'intermédiaire d'un canal de communication, et à délivrer une pluralité de séries de données démodulées (127a, 127b) ;
   un moyen de dépoinçonnement (114) destiné à dépoinçonner individuellement ladite pluralité de séries de données démodulées (127a, 127b) au moyen de configurations de poinçonnement (102a, 102b) qui sont identiques à celles utilisées par ladite source d'émission (100), et à délivrer une pluralité de séries de données dépoinçonnées (128a, 128b) ;
   un moyen de combinaison (115) destiné à combiner ladite pluralité de séries de données dépoinçonnées (128a, 128b) et à délivrer un résultat de combinaison ;
   un moyen de décodage de convolution (116) destiné à décoder ledit résultat de combinaison et à délivrer des données décodées (122) ;

   caractérisé en ce qu'il comprend en outre
   un moyen de mémoire de niveau de réception (301) destiné à mesurer le niveau de réception pour chaque série de données poinçonnées (126a, 126b) de ladite pluralité émise reçue par ledit moyen de réception/démodulation (112) et à mémoriser le résultat (R1, R2) de ladite mesure ; et
   et **en ce que** ledit moyen de combinaison (302) comprend en outre un moyen de pondération qui pondère ladite pluralité de séries de données dépoinçonnées (128a, 128b) en fonction desdits résultats de mesure (R1, R2) mémorisés avant de les combiner.

2. Système d'émission et de réception comprenant un émetteur (100), un récepteur (110, 310) et un canal de communication entre lesdits émetteur et récepteur ;
   ledit émetteur (100) comprenant :

   un moyen de codage convolutionnel (101) destiné à coder convolutionnellemént une série de données d'entrée (121) et à délivrer une série de données codées convolutionnellement (125) ;
   un moyen de poinçonnement (103) destiné à poinçonner individuellement ladite série de données codées convolutionnellement (125) au moyen d'une pluralité de configurations de poinçonnement (102a, 102b) et à délivrer une pluralité de séries de données poinçonnées (126a, 126b) ;
   un moyen de modulation/émission (105) destiné à moduler et à émettre ladite pluralité de séries de données poinçonnées (126a, 126b) ;

   ledit récepteur (110, 310) comprenant :

   un moyen de réception/démodulation (112) destiné à recevoir et à démoduler ladite pluralité de séries de données poinçonnées émises, et à délivrer une pluralité de séries de données démodulées (127a, 127b) ;
   un moyen de dépoinçonnement (114) destiné à dépoinçonner individuellement ladite pluralité de séries de données démodulées (127a, 127b) au moyen de configurations de poinçonnement (102a, 102b) qui sont identiques à celles utilisées par ladite source d'émission (100), et à délivrer une pluralité de séries de données dépoinçonnées (128a, 128b) ;
   un moyen de combinaison (115) destiné à combiner ladite pluralité de séries de données dépoinçonnées (128a, 128b) et à délivrer un résultat de combinaison ;
   un moyen de décodage de convolution (116) destiné à décoder ledit résultat de combinaison et à délivrer des données décodées (122) ;

   caractérisé par
   un moyen de mémoire de niveau de réception (301) destiné à mesurer le niveau de réception pour chaque série de données poinçonnées (126a, 126b) de ladite pluralité émise reçue par ledit moyen de réception/démodulation (112) et à mémoriser le résultat (R1, R2) de ladite mesure ; et
   et en ce que ledit moyen de combinaison (115) comprend en outre un moyen de pondération qui pondère ladite pluralité de séries de données dépoinçonnées (128a, 128b) en fonction desdits résultats de mesure (R1, R2) mémorisés avant de les combiner.

3. Système d'émission et de réception selon la revendication 2, **caractérisé en ce que**
   ledit moyen de modulation/émission (105) émet ladite pluralité de séries de données poinçonnées (126a, 126b) par l'intermédiaire d'au moins un canal de communication ;
   en ce que ledit moyen de réception/démodulation (112) reçoit ladite pluralité émise de séries de données poinçonnées par l'intermédiaire d'au moins un canal de communication.

4. Système d'émission et de réception selon la revendication 2 ou 3, **caractérisé en ce que**
   ledit émetteur (100) comprend en outre
   un moyen de génération (102) de configurations de poinçonnement multiples destiné à générer une pluralité prédéterminée de configurations de

poinçonnements (102a, 102b) ayant un taux de poinçonnement identique, mais étant différents dans leurs configurations de blocs ;

un moyen de commande de synchronisation d'émission en diversité (104) destiné à délivrer un signal de commande de synchronisation d'émission en diversité (123) afin de mener une émission en diversité à des intervalles de temps prédéterminés ; ledit émetteur (100) étant **caractérisé en ce que** :

ledit moyen de poinçonnement (103) utilise chaque configuration de ladite pluralité de (102a, 102b) pour poinçonner ladite série de données codées convolutionnellement (125) ;
en ce que lesdits moyens de modulation/émission (105) sont des moyens de modulation/émission (105) en diversité de temps qui modulent et émettent une par une ladite pluralité de séries de données poinçonnées (126a, 126b) comme des données d'émission en diversité de temps à des intervalles de temps prédéterminés, en réponse audit signal de commande de synchronisation d'émission en diversité (123) ;

en ce que ledit récepteur (110, 310) comprend en outre

un moyen de commande de synchronisation de réception en diversité (111) destiné à délivrer un signal prédéterminé de commande de synchronisation de réception en diversité afin de mener la réception du signal d'émission en diversité de temps auxdits intervalles de temps prédéterminés ;
un moyen de génération (113) de configurations de poinçonnement multiples destiné à générer des configurations de poinçonnements (102a, 102b) qui sont identiques à la pluralité prédéterminée de configurations de poinçonnement (102a, .102b) de l'émetteur (100) ;

ledit récepteur (110, 310) étant **caractérisé en ce que**

ledit moyen de réception/démodulation (112) est un moyen de réception/démodulation (112) en diversité de temps destiné à recevoir et à démoduler ledit signal d'émission en diversité de temps de l'émetteur ;
en ce que ledit moyen de dépoinconnement (114) dépoinçonne chaque série de données poinçonnées (126a, 126b) de la pluralité reçue et démodulée par ledit moyen de réception/démodulation (112) en diversité de temps au moyen de ladite pluralité de configurations de poinçonnement (102a, 102b) délivrées par ledit moyen de génération (113) de configurations de poinçonnement multiples du récepteur.

5. Système d'émission et de réception selon la revendication 4, **caractérisé en ce que**
lesdites séries de données démodulées (127a, 127b) délivrées par ledit moyen de réception/démodulation (112) en diversité de temps sont des valeurs numériques quantifiées avec un nombre prédéterminé d'éléments binaires ;
en ce que ledit processus de dépoinçonnement mené par le premier moyen de dépoinçonnement (114) insère une valeur médiane entre deux valeurs numériques correspondant à une marque et à un espace ;
en ce que ledit processus de combinaison mené par ledit moyen de combinaison (115) ajoute une valeur numérique à chaque symbole dans un bloc unité de ladite pluralité de séries de données dépoinçonnées (128a, 128b) ; et
en ce que ledit moyen de décodage de convolution (116) contient un moyen logiciel de quantification de Viterbi destiné à exécuter une décision logicielle de Viterbi.

6. Système d'émission et de réception selon la revendication 4 ou 5, **caractérisé en ce que** les emplacements de poinçonnement dans ladite pluralité de configurations de poinçonnement (102a, 102b) sont fixés à l'avance de manière à ce que lesdits emplacements de poinçonnement ne se chevauchent pas dans ladite pluralité de configurations.

7. Système d'émission et de réception selon l'une des revendications 4 à 6, **caractérisé en ce que** lesdits moyens de génération (102, 113) de configurations multiples de poinçonnement dans le récepteur et l'émetteur comprennent chacun :

un moyen de génération (201) de matrice de référence destiné à générer une matrice de référence des configurations de poinçonnement (102a, 102b), et
un moyen (202) de conversion de matrice destiné à délivrer une configuration de poinçonnement différente pour chaque branche de la diversité en une quelconque ou plus des rangées, colonnes et éléments de ladite matrice de référence.

8. Système d'émission et de réception selon l'une des revendications 3 à 7, **caractérisé en ce que**
ledit émetteur (400) comprend un moyen de génération (102) de configurations de poinçonnement multiples destiné à générer une pluralité prédéterminée de configurations de poinçonnements (102a, 102b) ayant un taux de poinçonnement identique, mais étant différents dans leurs configurations de blocs ;

en ce que ledit moyen de modulation/émission (105) est un moyen d'émission (401) de signaux multiplex à partage de code destiné à émettre ladite pluralité de séries de données poinçonnées (126a, 126b) et émet ceux-ci simultanément ;
en ce que le récepteur (410) comprend un moyen de génération (113) de configurations de poinçonnement multiples destiné à générer une pluralité prédéterminée de configurations de poinçonnements (102a, 102b) qui sont identiques à la pluralité de configurations de poinçonnement (102a, 102b) générées par le moyen de génération (102) de configurations de poinçonnement multiples de l'émetteur (400) ; et
en ce que ledit moyen de réception/démodulation (112) est un moyen de réception (402) de signaux multiplex à partage de code destiné à recevoir et à démoduler ladite pluralité de séries de données poinçonnées émises et à délivrer une pluralité de séries de données démodulées (127a, 127b).

9. Système d'émission et de réception selon l'une des revendications 4 à 8, **caractérisé en ce que**
ledit émetteur est une station d'émission terrestre (710) d'un système d'émetteur-récepteur à canal satellite ;
en ce que ledit récepteur est une station de réception terrestre (720) d'un système d'émetteur-récepteur à satellite ; et
en ce que ledit système d'émission et de réception comprend en outre une pluralité de stations de répéteurs (700a, 700b) qui reçoivent les séries de données codées convolutionnellement et poinçonnées émises par ladite station d'émission terrestre (710) et propagent les séries de données codées convolutionnellement et poinçonnées vers ladite station de réception terrestre (720).

10. Système d'émission et de réception selon l'une des revendications 3 à 9, **caractérisé en ce que**
ledit système d'émission et de réception comprend une pluralité de stations terrestres (710, 720) communiquant les unes avec les autres par l'intermédiaire de ladite pluralité de stations de répéteurs (700a, 700b), chaque station terrestre comprenant une station terrestre d'émission et une station terrestre de réception.

11. Système d'émission et de réception comprenant- une pluralité d'émetteurs (500a, 500b) destinés à émettre des séries de données d'information identiques (521), et un récepteur (510) destiné à recevoir une pluralité de signaux émis par lesdits émetteurs (500a, 500b), chacun des émetteurs de ladite pluralité comprenant :

des moyens de codage convolutionnel (501a, 501b) destiné à coder convolutionnellement et à délivrer lesdites séries de données d'information identiques (521) ;
des moyens de génération (502a, 502b) de configurations de poinçonnement destiné à générer une configuration de poinçonnement ;
des moyens de poinçonnement (503a, 503b) destinés à poinçonner une série de données codées convolutionnellement (125) délivrées par lesdits moyens de codage convolutionnel (501a, 501b) au moyen de la configuration de poinçonnement délivrée par lesdits moyens de génération (502a, 502b) de configurations de poinçonnement, et à délivrer une série de données poinçonnées ;
des moyens de commande d'émission (504a, 504b) destinés à délivrer une synchronisation d'émission prédéterminée et une fréquence d'émission prédéterminée audit émetteur afin de commander l'émission ; et
des premiers moyens de modulation/émission (505a, 505b) destinés à moduler et à émettre lesdites séries de données poinçonnées en réponse auxdites synchronisation d'émission et fréquence d'émission

ledit récepteur (510) comprenant :

un moyen de commande de réception (511) destiné à délivrer une synchronisation de réception prédéterminée et une fréquence de réception prédéterminée audit émetteur afin de commander le processus de réception ;
un moyen de réception/démodulation (512) destiné à recevoir et à démoduler ladite pluralité de séries de données poinçonnées (126a, 126b) de ladite pluralité d'émetteurs en réponse auxdites synchronisation de réception prédéterminée et fréquence de réception prédéterminée, et à délivrer des séries individuelles de données démodulées (127a, 127b) ;
un moyen de génération (113) de configurations de poinçonnement multiples destiné à générer une pluralité de configurations de poinçonnement (102a, 102b) ;
un moyen de dépoinçonnement (114) destiné à dépoinçonner chacune des séries de données démodulées (127a, 127b) et à délivrer des séries individuelles de données dépoinçonnées (128a, 128b) ;
un moyen de combinaison (115) destiné à combiner chaque symbole dans un bloc unité desdites séries plurales de données dépoinçonnées (128a, 128b), et à délivrer le résultat de combinaison ; et
un moyen de décodage de convolution (116) destiné à décoder la convolution dudit résultat de combinaison,

caractérisé en ce que lesdites configurations de poinçonnement (102a, 102b) générées par lesdits moyens de génération de configurations de poinçonnement (502a, 502b) de ladite pluralité d'émetteurs ont un taux de poinçonnement identique, mais sont différents dans leurs configurations de blocs ;
en ce que ledit moyen de commande de réception (511) commande la réception de ladite pluralité de séries de données poinçonnées (126a, 126b) émises par ladite pluralité d'émetteurs ;
en ce que ledit moyen de réception/démodulation (512) reçoit et démodule ladite pluralité de séries de données poinçonnées (126a, 126b) émises par chacun desdits émetteurs ;
en ce que lesdites configurations de poinçonnement (102a, 102b) générées par ledit moyen de génération (113) de configurations de poinçonnement multiples dudit récepteur sont identiques aux configurations de poinçonnement individuelles (102a, 102b) de ladite pluralité d'émetteurs (500a, 500b) ;
en ce que ledit moyen de dépoinçonnement (114) dépoinçonne chacune des séries de données démodulées (127a, 127b) au moyen d'une configuration de poinçonnement qui est identique à celle utilisée par ledit émetteur respectif pour poinçonner les données respectives ; et
en ce que ledit système d'émission et de réception fixe à l'avance lesdites fréquences d'émission à une valeur approximativement égale et sélectionné à l'avance les synchronisations d'émission de manière à ce que les synchronisations d'émission de ladite pluralité d'émetteurs ne se chevauchent pas les unes avec les autres, et **en ce que** chaque émetteur émet lesdites séries poinçonnées de données d'information identiques codées convolutionnellement et avec des configurations de poinçonnement différentes (102a, 102b) selon une synchronisation différente.

12. Système d'émission et de réception selon la revendication 9, **caractérisé en ce que**
lesdits moyens de commande d'émission (504a, 504b) fixent à l'avance lesdites synchronisations d'émission à une valeur approximativement égale et sélectionnent à l'avance lesdites fréquences d'émission de manière à ce que les fréquences d'émission de ladite pluralité d'émetteurs ne se chevauchent pas les unes avec les autres ; et
en ce que ledit moyen de commande de réception (511) fixe à l'avance les synchronisations de réception et les fréquences de réception de manière à ce qu'elles correspondent auxdites synchronisations d'émission et auxdites fréquences d'émission de ladite pluralité d'émetteurs.

13. Système d'émission et de réception selon la revendication 9, **caractérisé en ce que**
lesdits moyens de commande d'émission (504a, 504b) fixent à l'avance les synchronisations d'émission et les fréquences d'émission de manière à ce que les fréquences d'émission de ladite pluralité d'émetteurs ne se chevauchent pas les unes avec les autres ; et
en ce que ledit moyen de commande de réception (511) fixe à l'avance les synchronisations de réception et les fréquences de réception de manière à ce qu'elles correspondent auxdites synchronisations d'émission et auxdites fréquences d'émission desdits moyens de commande d'émission.

14. Système d'émission et de réception selon la revendication 11, dans lequel
lesdits moyens de commande d'émission (504a, 504b) fixent à l'avance les synchronisations d'émission et les fréquences d'émission à une valeur approximativement égale parmi ladite pluralité d'émetteurs ;
dans lequel lesdits moyens de modulation/émission (505a, 505b) sont des moyens d'émission de signaux multiplex à partage de code destinés à émettre ladite pluralité de séries de données poinçonnées (126a, 126b) ;
dans lequel ledit moyen de réception (511) dans ledit dispositif de réception fixe à l'avance les synchronisations de réception et les fréquences de réception de manière à ce qu'elles correspondent avec lesdites synchronisations d'émission et lesdites fréquences d'émission desdits moyens de commande d'émission ; et
dans lequel ledit moyen de réception/démodulation (512) est un moyen de réception de signaux multiplex à partage de code destiné à recevoir et à démoduler lesdites séries poinçonnées de données d'information identiques codées convolutionnellement et avec des configurations de poinçonnement différentes (102a, 102b) émises, et à délivrer une pluralité de séries de données démodulées (127a, 127b).

15. Système d'émission et de réception comprenant un émetteur (600), une pluralité de récepteurs (610a, 610b) destinés à recevoir un signal délivré par ledit émetteur ;
ledit émetteur (600) comprenant :

un moyen de codage convolutionnel (101) destiné à délivrer une série de données d'entrée (631) par codage convolutionnel desdites séries de données ;
un moyen de génération (102) de configurations de poinçonnement multiples destiné à générer et à délivrer une pluralité prédéterminée de configurations de poinçonnement (102a, 102b) ayant un taux de poinçonnement identique, mais différents dans leur configuration de

blocs ;

un moyen de poinçonnement (103) destiné à poinçonner lesdites séries de données codées convolutionnellement (125) au moyen de chaque configuration de poinçonnement (102a, 102b) de ladite pluralité prédéterminée et à délivrer une pluralité prédéterminée de séries différentes de données poinçonnées ;

un moyen de commande d'émission (601) destiné à délivrer une synchronisation d'émission prédéterminée et une fréquence d'émission prédéterminée pour ledit émetteur ; et

un moyen de modulation/émission (602) destiné à moduler et à émettre chaque série différente de données poinçonnées de ladite pluralité en réponse à ladite synchronisation d'émission et à ladite fréquence d'émission ;

chacun des récepteurs (610a, 610b) de ladite pluralité comprenant :

des moyens de commande de réception (611a, 611b) destinés à délivrer une synchronisation d'émission prédéterminée et une fréquence d'émission prédéterminée afin de commander le processus de réception ;

des moyens de réception/démodulation (612a, 612b) destinés à recevoir et à démoduler une série de données poinçonnées émises en conformité avec ladite synchronisation de réception prédéterminée et avec ladite fréquence de réception prédéterminée, et à délivrer une série de données démodulées;

des moyens de génération (613a, 613b) de configurations de poinçonnement destinés à générer une configuration de poinçonnement ,; et

des moyens de dépoinçonnement (614a, 614b). destinés à dépoinçonner lesdites séries de données démodulées au moyen desdites configurations de poinçonnement délivrées par lesdits moyens de génération (613a, 613b) de configurations de poinçonnement, et à délivrer une série de données dépoinçonnées (128a, 128b) ; et

étant **caractérisé en ce que**

lesdits moyens de génération (613a, 613b) de configurations de poinçonnement dans ladite pluralité de récepteurs (610a, 610b) génèrent une configuration de poinçonnement qui est identique à la configuration de poinçonnement utilisée pour poinçonner la série de données poinçonnées que reçoit le récepteur respectif ;

en ce que la synchronisation d'émission dans l'émetteur (600) est telle que les émissions individuelles des séries individuelles de données poinçonnées ne se chevauchent pas ; et

en ce que ladite fréquence d'émission dans l'émetteur est approximativement égale parmi lesdites émissions individuelles ;

en ce que le système d'émission et de réception comprend en outre un dispositif de traitement de sortie (620) destiné à accumuler les séries de données reçues dans ladite pluralité de récepteurs, ledit dispositif de traitement de sortie comprenant :

un moyen de combinaison (621) destiné à combiner chaque symbole dans un bloc unité dans lesdites séries de données dépoinçonnées (633a, 633b) obtenues à partir de chaque récepteur de ladite pluralité et à délivrer le résultat de la combinaison ;

un moyen de décodage de convolution (622) destiné à décoder la convolution dudit résultat de combinaison.

16. Système d'émission et de réception selon la revendication 13, **caractérisé en ce que**
ledit moyen de commande d'émission (601) fixe à l'avance lesdites synchronisations des émissions individuelles de manière à ce qu'elles soient approximativement égales et sélectionne à l'avance lesdites fréquences d'émission de manière à ce que les fréquences d'émission ne se chevauchent pas ; et
en ce que lesdits moyens de commande de réception (611a, 611b) fixent à l'avance les synchronisations de réception et les fréquences de réception pour chaque récepteur (610a, 610b) de manière à ce qu'elles correspondent auxdites synchronisations d'émission et auxdites fréquences d'émission dudit moyen de commande d'émission 601).

17. Système d'émission et de réception selon la revendication 13, **caractérisé en ce que**
ledit moyen de commande d'émission (601) fixe à l'avance les synchronisations d'émission et les fréquences d'émission de manière à ce que les fréquences d'émission ne se chevauchent pas ; et
en ce que lesdits moyens de commande de réception (611a, 611b) fixent à l'avance les synchronisations de réception et les fréquences de réception pour chaque récepteur de manière à ce qu'elles correspondent auxdites synchronisations d'émission et auxdites fréquences d'émission dudit moyen de commande d'émission 601).

18. Système d'émission et de réception selon la revendication 15, **caractérisé en ce que**
ledit moyen de commande d'émission (601) fixe à l'avance les synchronisations des émissions et les fréquences d'émission de manière à ce qu'elle soient approximativement égales ;
en ce que le dit moyen de modulation/émission (602) est un moyen d'émission de signaux multiplex

à partage de code destiné à émettre ladite pluralité de séries de données poinçonnées (126a, 126b) ; **en ce que** lesdits moyens de commande de réception (6121a, 611b) dans ledit dispositif de réception fixent à l'avance les synchronisations de réception et les fréquences de réception pour chaque récepteur de manière à ce qu'elles correspondent auxdites synchronisations d'émission et auxdites fréquences d'émission dudit moyen de commande d'émission (601) ; et
en ce que lesdits moyens de réception/démodulation (612a, 612b) sont des moyens de réception de signaux multiplex à partage de code destinés à recevoir et à démoduler lesdites séries poinçonnées de données d'information identiques codées convolutionnellement et avec des configurations de poinçonnement différentes (102a, 102b), et à délivrer une pluralité de séries de données démodulées.

19. Procédé de réception comprenant les étapes consistant à :

recevoir et démoduler un signal émis par l'intermédiaire d'un canal de communication, et délivrer une pluralité de séries de données démodulées (127a, 127b) ;
dépoinçonner ladite pluralité de séries de données démodulées (127a, 127b) au moyen de configurations de poinçonnement (102a, 102b) qui sont identiques à ladite pluralité de configurations de poinçonnement (102a, 102b) utilisées dans ladite étape de poinçonnement, et délivrer une pluralité de séries de données dépoinçonnées (128a, 128b) ;
combiner ladite pluralité de séries de données dépoinçonnées (128a, 128b) et délivrer le résultat de combinaison ; et
décoder la convolution dudit résultat de combinaison et délivrer des données décodées (122) ;

caractérisé en ce que
l'étape de combinaison comprend une étape de pondération, qui pondère chaque série de données dépoinçonnées (128a, 128b) de la pluralité émise en fonction du niveau de réception de chaque sérié de données poinçonnées (126a, 126b) de la pluralité émise avant que la pluralité de séries des données dépoinçonnées (128a, 128b) ne soit combinée.

FIG. 1A

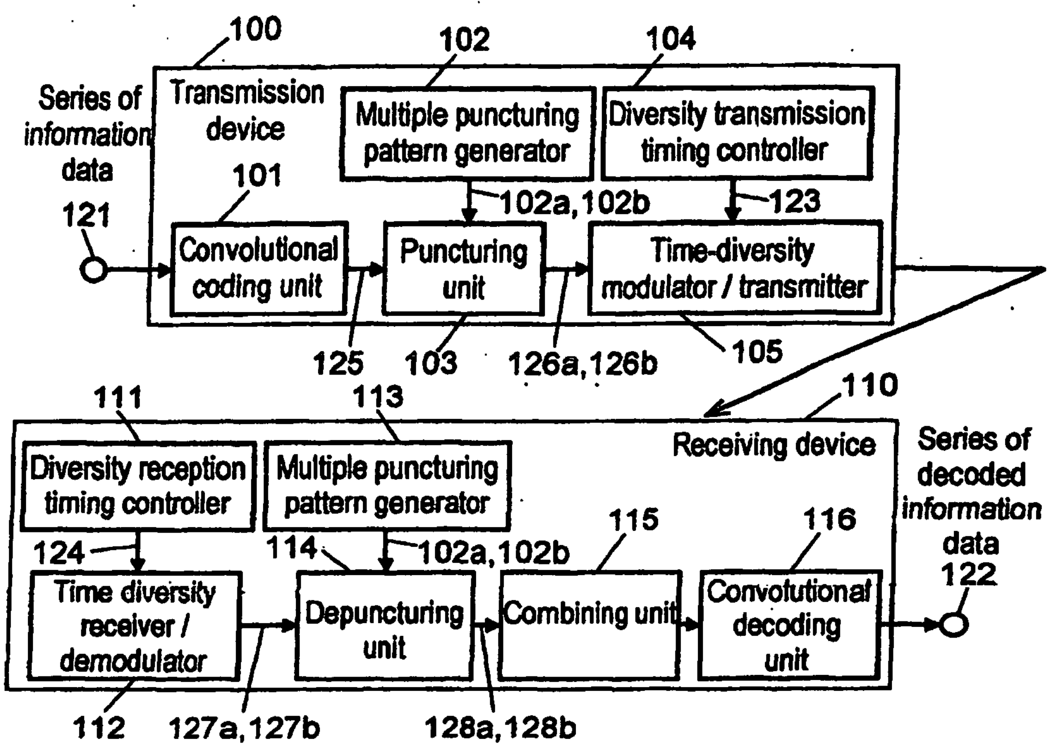

100
102
104
Series of information data
Transmission device
Multiple puncturing pattern generator
Diversity transmission timing controller
101
121
102a,102b
123
Convolutional coding unit
Puncturing unit
Time-diversity modulator / transmitter
125
103
126a,126b
105
111
113
110
Receiving device
Series of decoded information data
Diversity reception timing controller
Multiple puncturing pattern generator
124
114
102a,102b
115
116
122
Time diversity receiver / demodulator
Depuncturing unit
Combining unit
Convolutional decoding unit
112
127a,127b
128a,128b

FIG. 1B

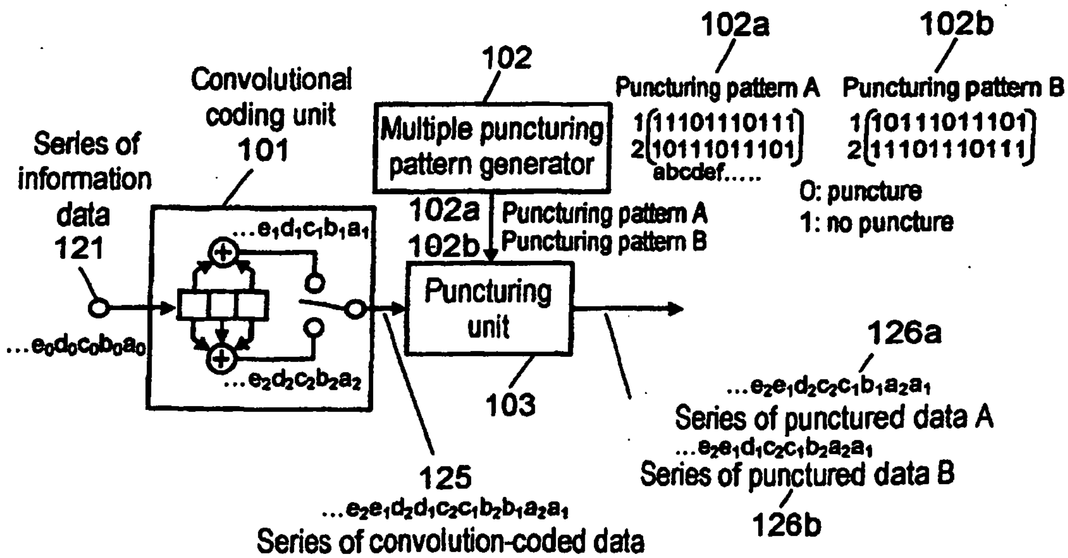

102a
102b
102
Puncturing pattern A
Puncturing pattern B
Convolutional coding unit
101
Series of information data
121
Multiple puncturing pattern generator
1 11101110111
2 10111011101
abcdef.....
1 10111011101
2 11101110111
0: puncture
1: no puncture
102a Puncturing pattern A
102b Puncturing pattern B
...e₁d₁c₁b₁a₁
Puncturing unit
...e₀d₀c₀b₀a₀
...e₂d₂c₂b₂a₂
126a
...e₂e₁d₂c₂c₁b₁a₂a₁
103
Series of punctured data A
...e₂e₁d₁c₂c₁b₂a₂a₁
125
Series of punctured data B
...e₂e₁d₂d₁c₂c₁b₂b₁a₂a₁
126b
Series of convolution-coded data

FIG. 2A

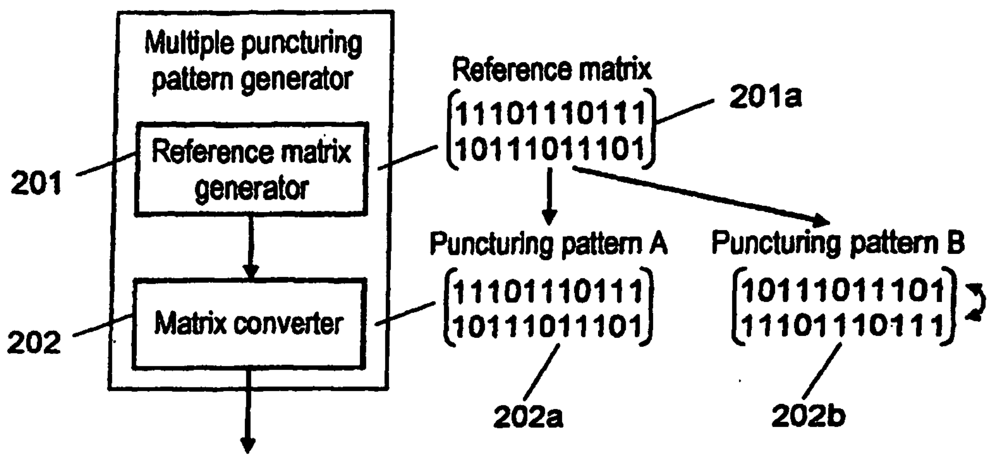

Multiple puncturing pattern generator
Reference matrix generator
Matrix converter
201
202
Reference matrix
11101110111
10111011101
201a
Puncturing pattern A
11101110111
10111011101
202a
Puncturing pattern B
10111011101
11101110111
202b

FIG. 2B

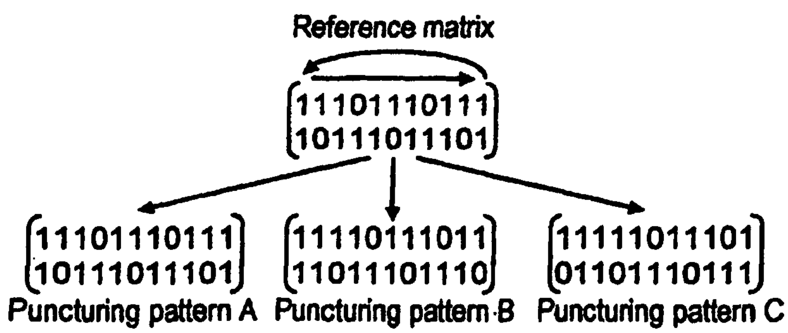

Reference matrix
11101110111
10111011101
11101110111
10111011101
Puncturing pattern A
11110111011
11011101110
Puncturing pattern B
11111011101
01101110111
Puncturing pattern C

FIG. 3

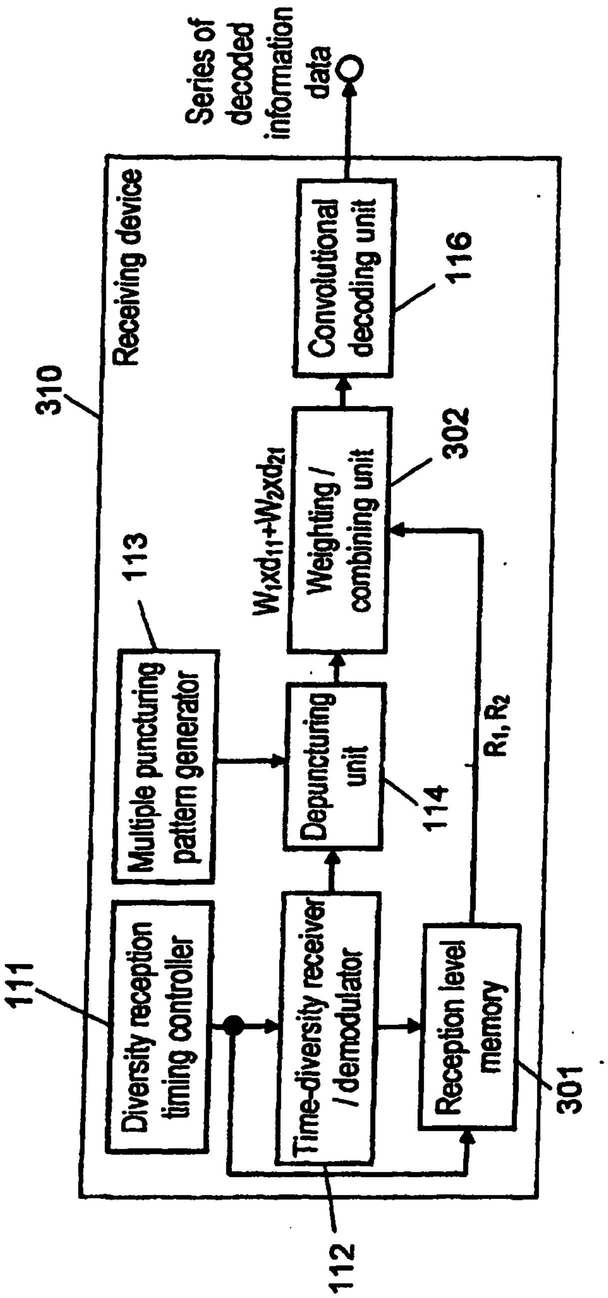

310
Receiving device
111
Diversity reception timing controller
113
Multiple puncturing pattern generator
Time-diversity receiver / demodulator
112
Depuncturing unit
114
Reception level memory
301
R_1, R_2
$W_1xd_{11}+W_2xd_{21}$
Weighting / combining unit
302
Convolutional decoding unit
116
Series of decoded information data

FIG. 4

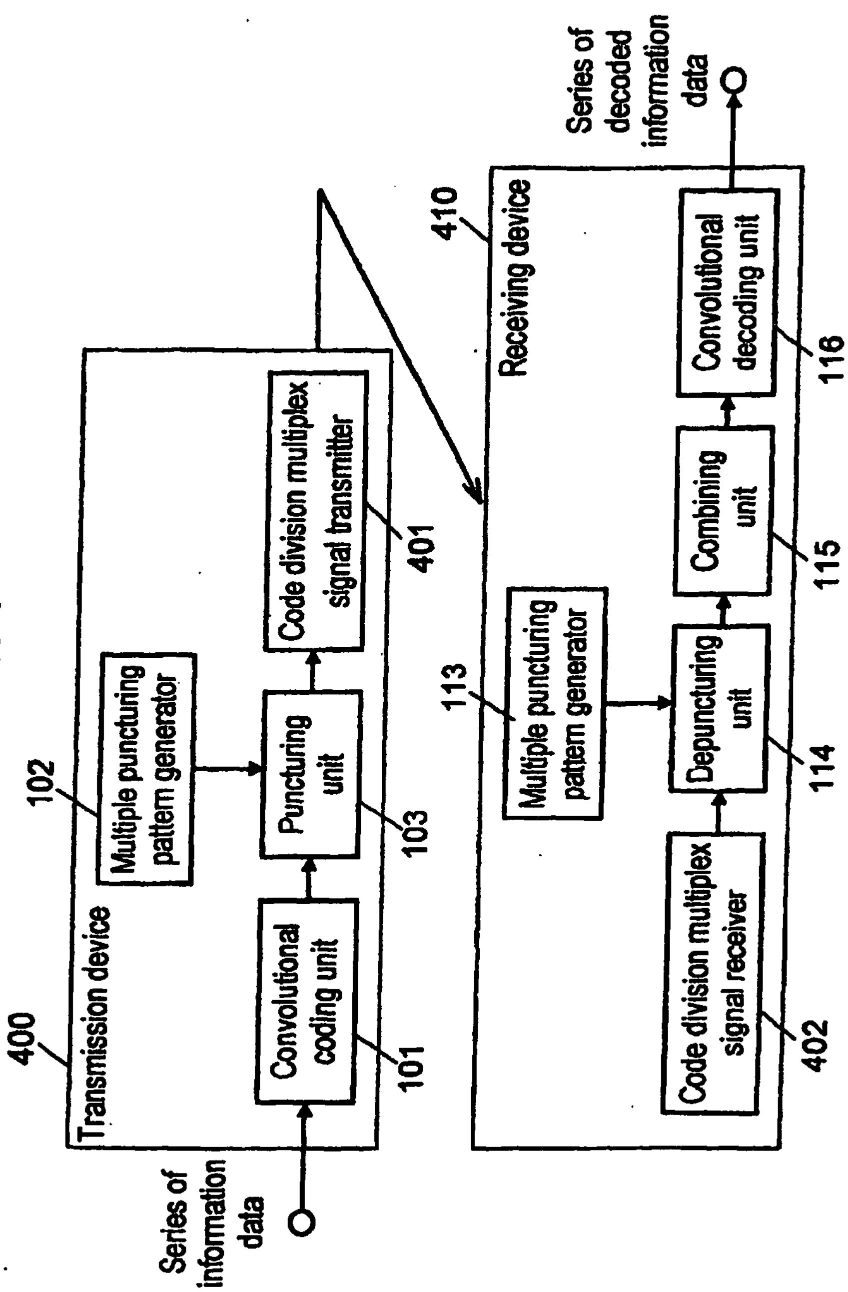

400
Transmission device
Series of information data
Convolutional coding unit
101
102
Multiple puncturing pattern generator
Puncturing unit
103
Code division multiplex signal transmitter
401
410
Receiving device
113
Multiple puncturing pattern generator
Code division multiplex signal receiver
402
Depuncturing unit
114
Combining unit
115
Convolutional decoding unit
116
Series of decoded information data

FIG. 5

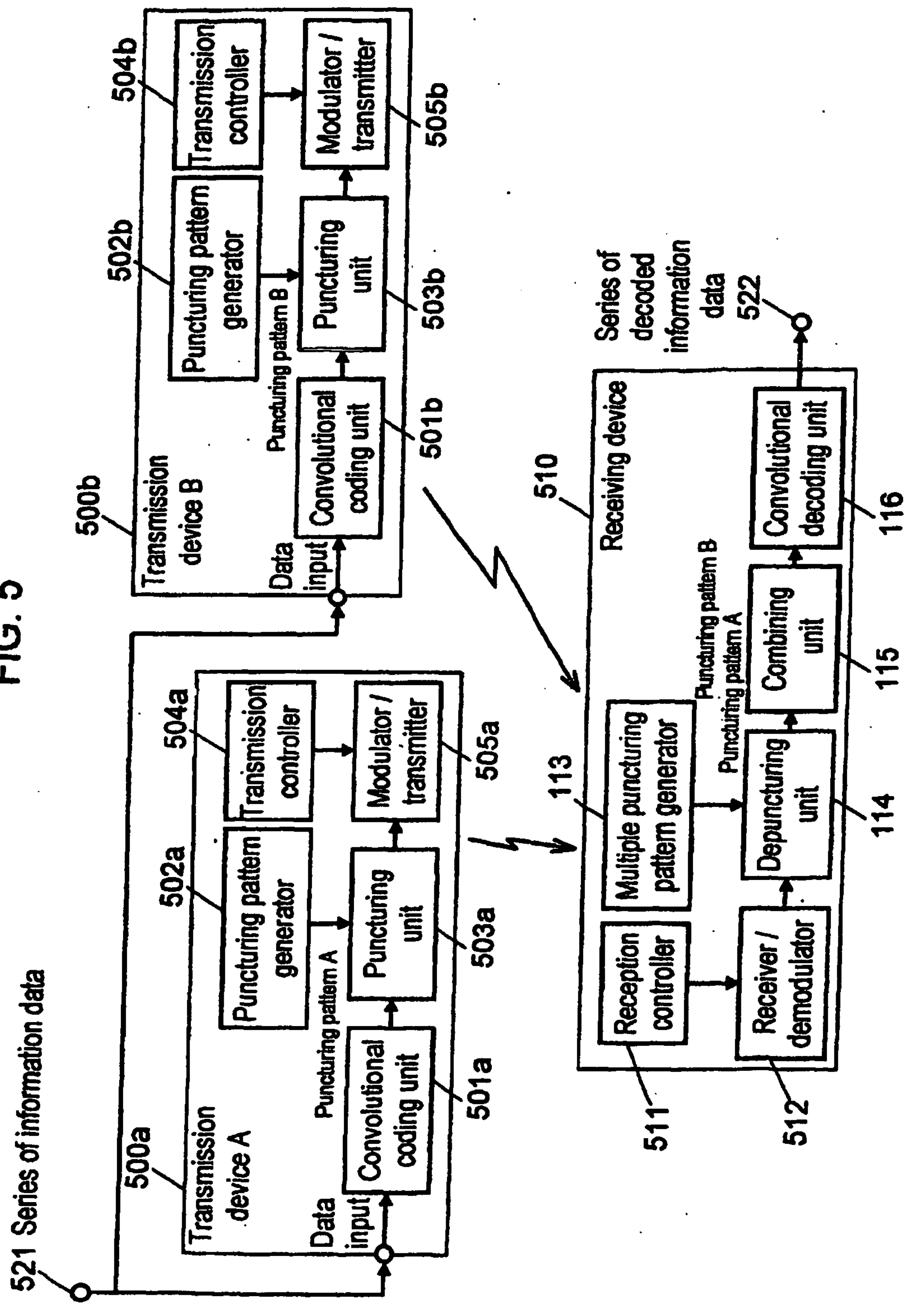
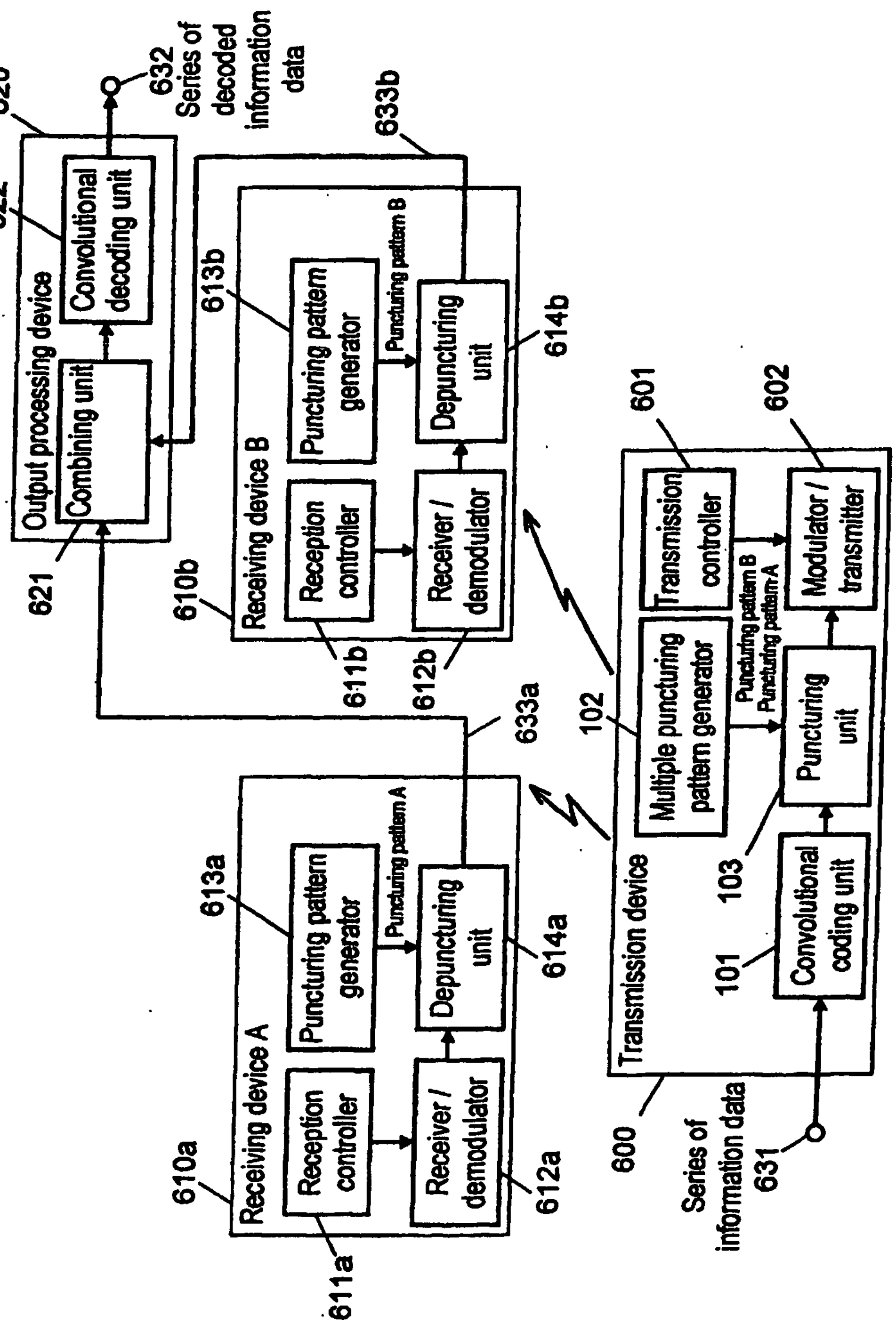

521 Series of information data
500a
Transmission device A
Data input
Convolutional coding unit
501a
Puncturing pattern A
Puncturing pattern generator
502a
Puncturing unit
503a
Transmission controller
504a
Modulator / transmitter
505a
500b
Transmission device B
Data input
Convolutional coding unit
501b
Puncturing pattern B
Puncturing pattern generator
502b
Puncturing unit
503b
Transmission controller
504b
Modulator / transmitter
505b
510
Receiving device
Reception controller
511
Receiver / demodulator
512
Multiple puncturing pattern generator
113
Puncturing pattern A
Puncturing pattern B
Depuncturing unit
114
Combining unit
115
Convolutional decoding unit
116
Series of decoded information data
522

FIG. 6



620
Output processing device
622
Convolutional decoding unit
632
Series of decoded information data
Combining unit
621
633b
610b
Receiving device B
613b
Reception controller
Puncturing pattern generator
Puncturing pattern B
Receiver / demodulator
Depuncturing unit
614b
611b
612b
633a
601
602
Transmission controller
Modulator / transmitter
102
Multiple puncturing pattern generator
Puncturing pattern B
Puncturing pattern A
Puncturing unit
610a
Receiving device A
613a
Reception controller
Puncturing pattern generator
Puncturing pattern A
Receiver / demodulator
Depuncturing unit
614a
612a
611a
Transmission device
103
101
Convolutional coding unit
600
Series of information data
631

FIG. 7

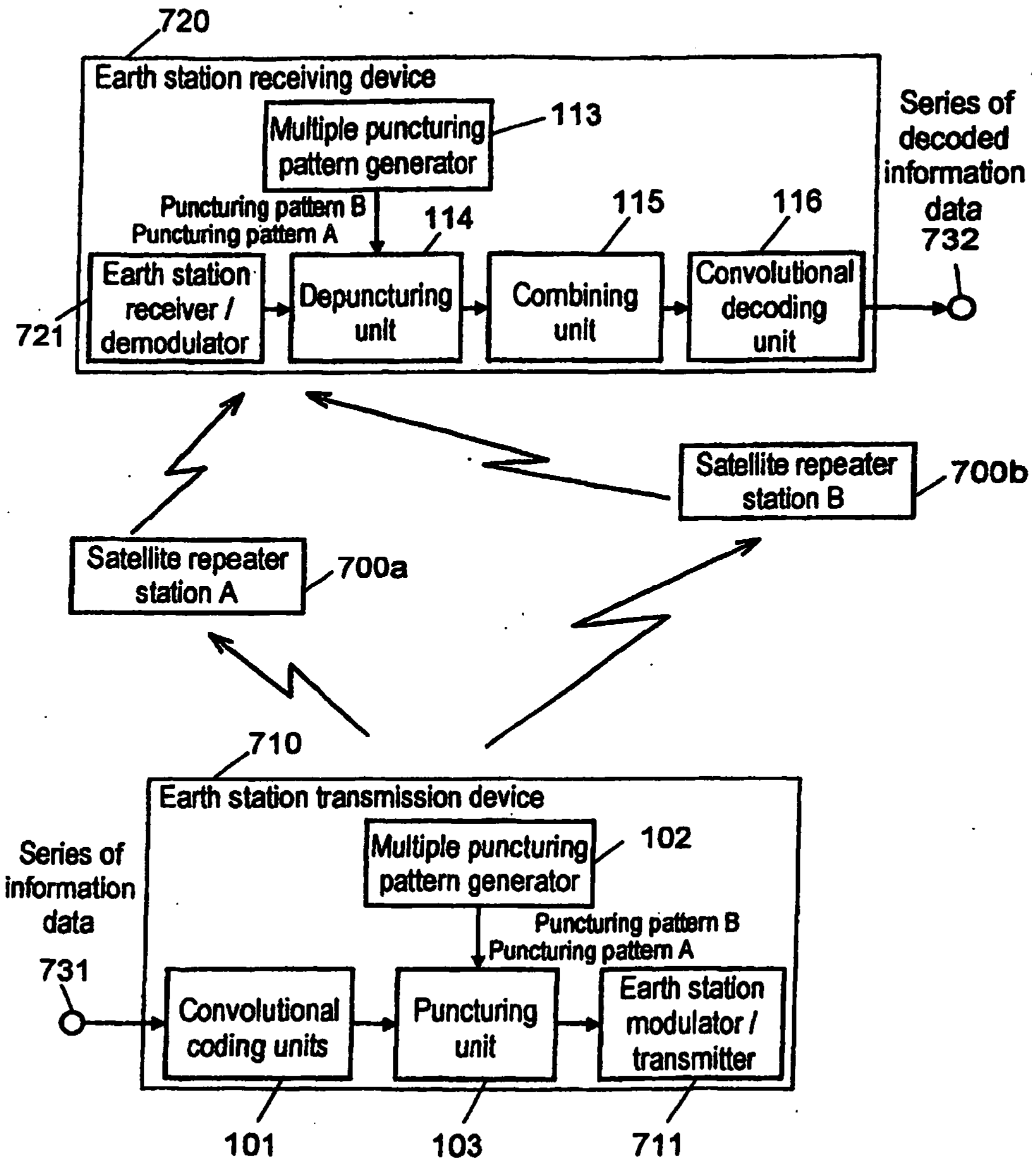

720
Earth station receiving device
Multiple puncturing pattern generator
113
Puncturing pattern B
Puncturing pattern A
114
115
116
Series of decoded information data
732
Earth station receiver / demodulator
721
Depuncturing unit
Combining unit
Convolutional decoding unit
Satellite repeater station B
700b
Satellite repeater station A
700a
710
Earth station transmission device
Multiple puncturing pattern generator
102
Series of information data
731
Puncturing pattern B
Puncturing pattern A
Convolutional coding units
Puncturing unit
Earth station modulator / transmitter
101
103
711

FIG. 8A PRIOR ART

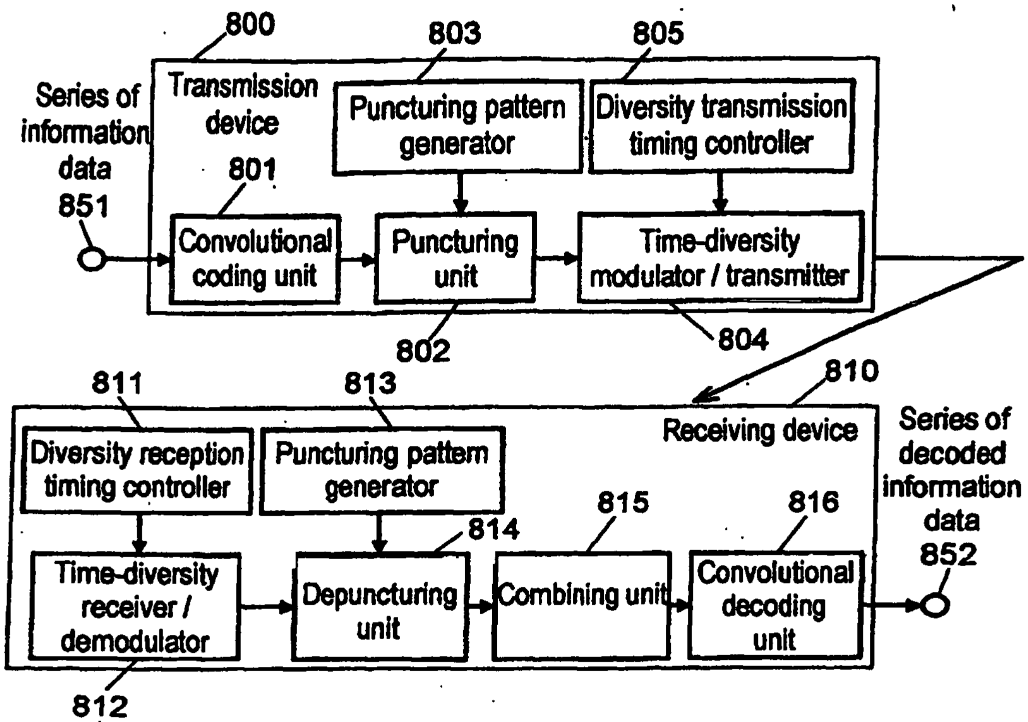


FIG. 8B PRIOR ART